ELECTRICAL ENGINEERING

JANUARY 1958

1957

ENGINEERING DEVELOPMENTS

"This BEND makes lighter distribution transformers possible . . . ."

"Primarily, the core determines the weight and size of a distribution transformer. Low-loss cores require less core steel, less copper in the windings, smaller tanks, less cooling oil and ultimately result in a reduction of overall dimensions.

"The problem then is to design lighter, smaller cores. How is it done?

"Well, actually, the solution was found more than a quarter of a century ago. It was then that Kuhlman first introduced the revolutionary idea of bending core iron to provide a continuous low-loss path for magnetic flux. This Kuhlman invention, utilizing the characteristics of grain-oriented steel, has been the basis of core development since.

"In recent times, bent iron cores, as opposed to stacked-lamination designs, have been responsible for such major improvements as: 100 KVA reduced to the former weight of a 75 KVA unit—75 KVA to the former weight of a 50 KVA unit, and so on down the line.

"Today, virtually all transformer manufacturers use some form of bent iron core. The original Kuhlman name 'Bent Iron' core is well worth remembering—for in all its adaptations, it's still the ***Bend*** that is the key to today's lightweight distribution transformers."

KUHLMAN ELECTRIC COMPANY

GENERAL OFFICES: Birmingham, Michigan

ELECTRICAL ENGINEERING

JANUARY 1958
Vol. 77, No. 1

Published monthly by American Institute of Electrical Engineers

THE COVER: The design on this month's cover symbolizes the six AIEE Divisions—Communications, General Applications, Industry, Instrumentation, Power, and Science and Electronics—and the world-wide coverage of each. Remo Cosentino, member of the AIEE editorial staff, is the artist.

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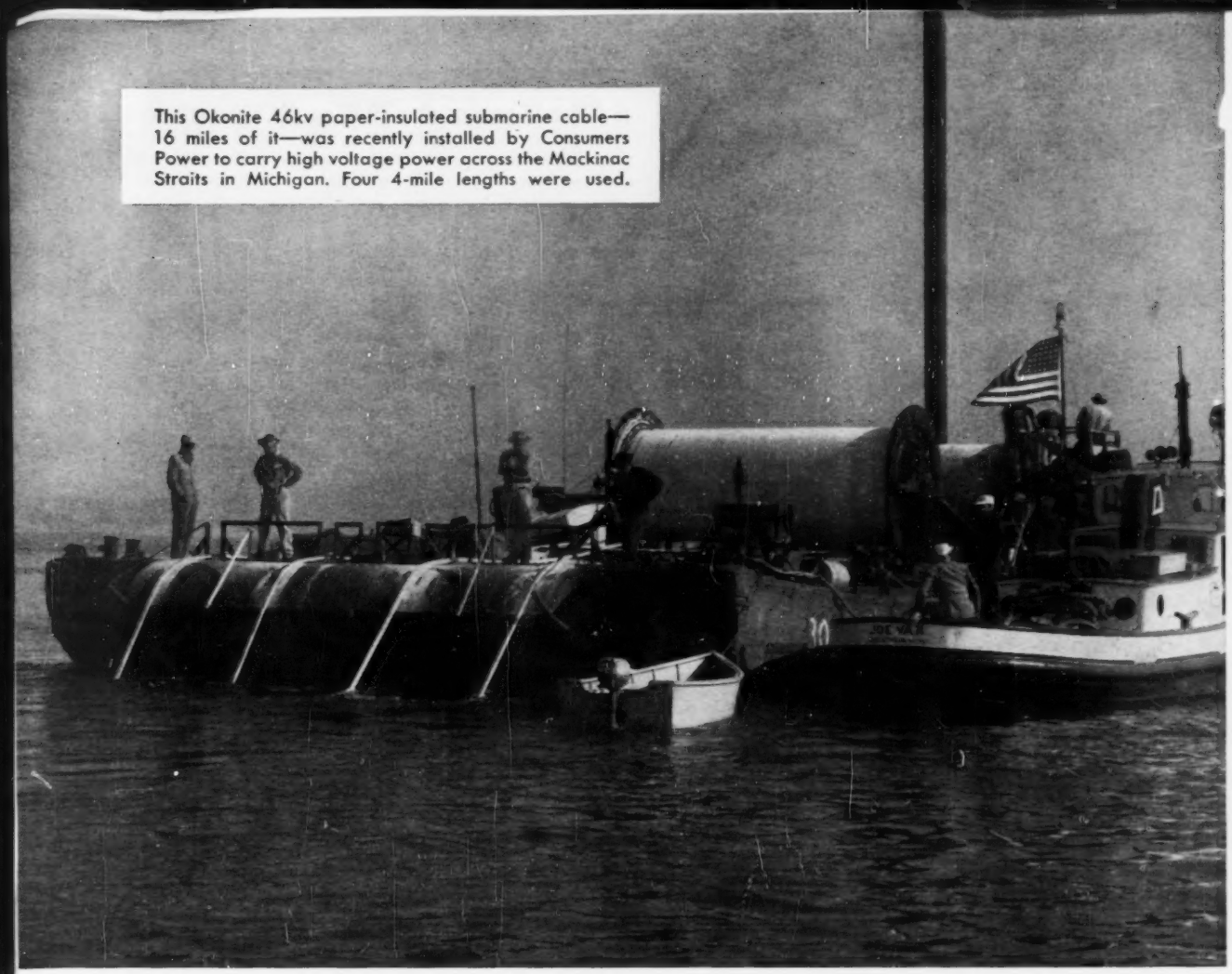

This Okonite 46kv paper-insulated submarine cable—16 miles of it—was recently installed by Consumers Power to carry high voltage power across the Mackinac Straits in Michigan. Four 4-mile lengths were used.

New Consumers Power circuit links upper and lower Michigan for first time

For critical power installations like this one, leading utilities most often place their confidence in Okonite.

Okonite solid type paper-insulated 46 kv submarine cable

Here's why.

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Combine these with the carefully researched and tested components of Okonite paper-insulated cables and you have real circuit security. Available with either copper or aluminum conductors, these features are discussed in detail in Bulletin EG-1052. Write for it today. The Okonite Co., Passaic, N. J.

where there's electrical power . . . there's **OKONITE CABLE**

4320

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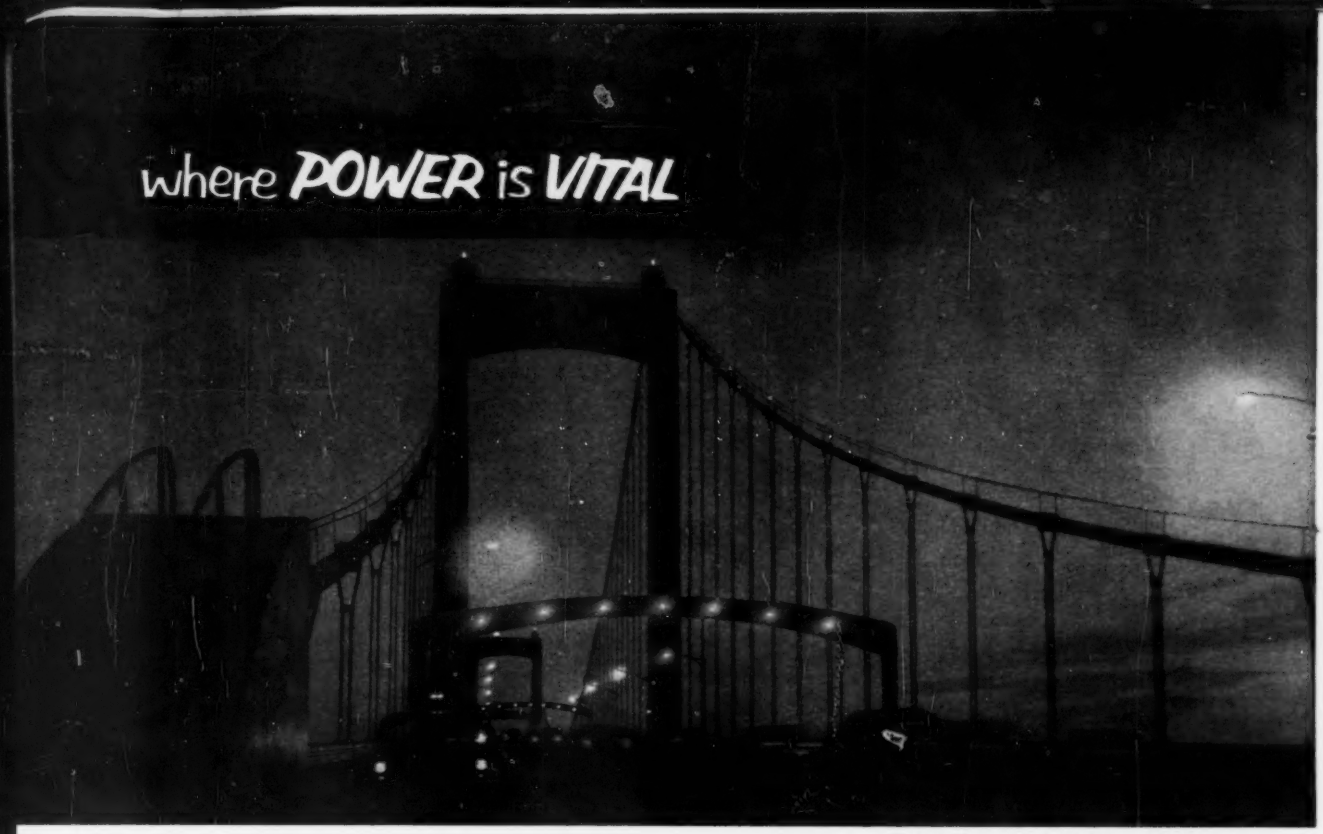

Night view of Walt Whitman Bridge spanning the Delaware between South Philadelphia and Gloucester City, N. J.

ASCO TRANSFER SWITCHES assure continuous lighting and power on the Walt Whitman Bridge

Along the six and one half mile length of the new Walt Whitman Bridge and its approaches, ASCO Automatic Transfer Switches stand ready to provide around-the-clock power insurance. Their duty: to transfer the bridge lighting and toll gate power and lighting load automatically to the alternate source in case of prime power failure.

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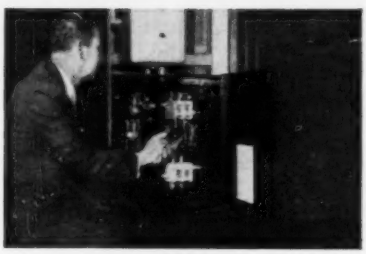
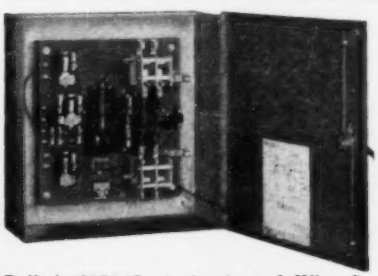
- *full phase protection* and other design features

Write for Booklet 596 describing how to select an adequate transfer switch. Or write in *on company letterhead*, specifying Catalog 57-S1, covering complete line of ASCO automatic transfer switches.



Engineer checks ASCO Transfer Switch built into thirteen power stations spotted every 1000 yards along length of bridge.



Bulletin 90804C, single phase, 3 Wire, 2 Pole Transfer Switch provides full protection against line drop below 70% of normal. ASCO Transfer Switches in sizes from 100 to 1200 amperes in A-C and D-C voltages to 750 volts protect life and property in every conceivable installation.

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MINIATURE VOICE MULTIPLEX EQUIPMENT FOR RADIO SYSTEMS

FOUR TO 124 CHANNELS

A series of miniaturized voice-multiplex systems providing from four to 124 voice channels over a radio system are now available. These systems have been designed specifically for radio use, and are not simply converted wire-line carrier-telephone systems. They have all the advantages which design for a specific application produces: High performance, small size, light weight, low cost, circuit simplicity, low power requirements, small number of tubes of a single type, low operating cost, low maintenance cost and high reliability.

CHANNEL CHARACTERISTICS

These systems provide a voice channel flat within 1 db from 300 to 3500 cycles, for each 4 kc of bandwidth occupied. Each channel is obtained as the lower sideband in a single-sideband suppressed-carrier amplitude-modulation arrangement, and is equipped with hybrid, signalling, and dialling circuits for all the standard 2-wire and 4-wire loop options. These systems are ordinarily arranged for a net loss of 3 db between 2-wire v-f loops or a net gain of 5 db between 4-wire v-f loops. Volume limiters are optional on all channels. On the high-frequency side the transmitting level is 0 dbm and the receiving level -20 to $+10$ dbm per channel. Crosstalk between channels is more than 55 db below these levels, and any harmonic in one channel is more than 30 db below these levels.

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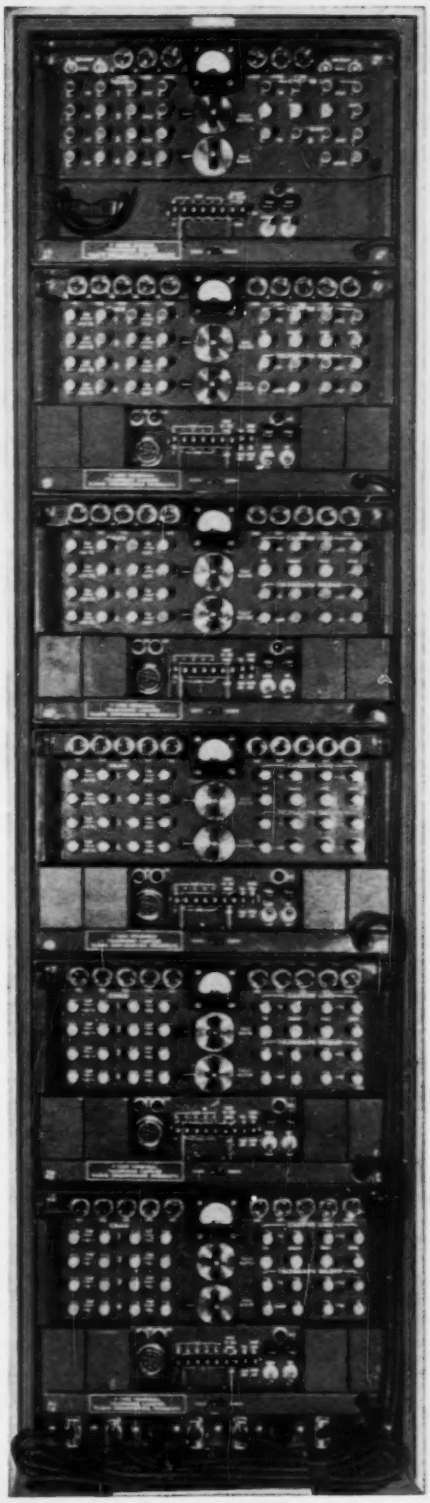
A telegraph channel is provided on which up to 8 teletype circuits can be multiplexed without double modulation. By dropping telephone channels, this telegraph group channel can be extended in width in 4 kc increments up to 20 kc, for data transmission service. An order-wire channel and telephone set are provided for each group of up to 24 channels. Channels can be added five at a time. Full flexibility is provided for dropping and inserting channel groups at repeater and terminal points. In all systems moderate lengths of 4-wire cable or open-wire line may be inserted between the multiplex equipment and the radio terminals.

Miniature frequency-shift telegraph multiplex equipment of from one to 24 channels is also available.



Type F1830 24-channel voice-multiplex terminal complete with hybrids, ringing and dialling circuits, and test facilities. Dimensions are 58" high, 16" wide and 8" deep. Power input 250 watts. Weight 326 lbs.

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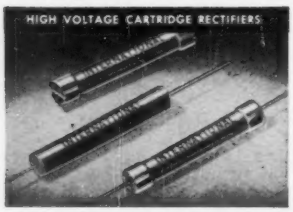
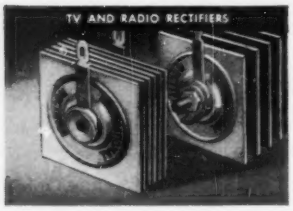
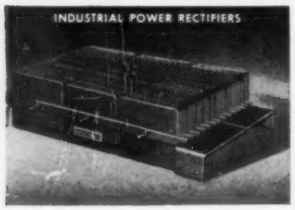


Designed for long life and reliability in Half-Wave, Voltage Doubler, Bridge, Center-Tap Circuits, and 3-Phase Circuit Types. Phenolic Cartridge and Hermetically Sealed types available. Operating temperature range: −65°C to +100°C. Specify **Bulletin H-2**



The widest range in the industry! Designed for Radio, Television, TV booster, UHF converter and experimental applications. Input ratings from 25 to 156 volts AC and up. DC output current 50 to 1,200 MA. Write for application information. **Bulletin ER-178-A**



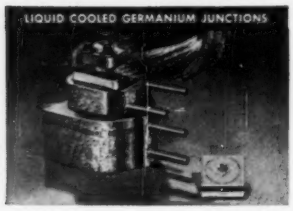
For all DC power needs from microwatts to kilowatts. Features: long life; compact, light weight and low initial cost. Ratings: to 250 KW, 50 ma to 2,300 amperes and up, 6 volts to 30,000 volts and up. Efficiency to 87%. Power factor to 95%. **Bulletin C-349**

GERMANIUM

This series of general purpose, high quality point contact diodes provide excellent rectification efficiency for very high frequency applications. Special "RED DOT" series available for ambient temperatures from −55° C to +100° C. **Bulletin SR-140.**

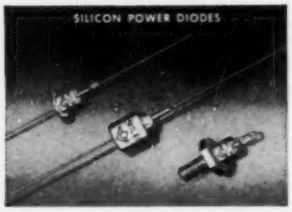
Extremely low reverse leakage values make this series ideal for magnetic amplifier applications. These units utilize 10 amp junctions—26 to 66 AC input volts rms—are available in a wide range of circuit types and DC current ratings. **Bulletin SR-148.**

Engineered for heavy power applications, these highly efficient forced air cooled units feature moisture and corrosion resistant housings. A complete series in each of 3 current ratings: 150, 330 and 500 Amperes @ 26 to 66 volts rms. Request **Bulletin GPR-2.**

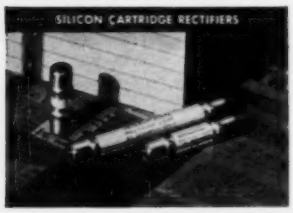


Liquid cooled for maximum power in minimum space. Junction rating: 670 amps at 26 to 66 volts rms. Housed in high-conductivity copper cast around special steel coils. Water, oil or other accepted coolants may be used. For complete data. **Bulletin GPR-2.**

SILICON



Hundreds of types in three basic styles, for operating temperatures from −55°C to +150°C. Up to 800ma DC output current per junction over a voltage range of 50 to 1,000 PIV. Hermetically sealed. For complete information on all types. **Bulletin SR-A.**



The answer to tough miniaturization problems! Ratings for high temperature applications: from 1000 volts PIV at 100ma half-wave DC output to 16,000 volts PIV at 45ma. Hermetically sealed, metallized ceramic housing. Request **Bulletin SR-139B**

The most conservatively rated silicon rectifiers in the industry! When fin-mounted, the convection cooled rating at 45°C ambient is 30 amps rectified dc output; 115 amps under forced cooled conditions. All-welded, hermetically sealed. **Request Bulletin SR-143 D.**

These units consist of hermetically sealed junction diodes mounted on copper cooling fins, stacked to include the interconnections required for specific circuits. Junction ratings: 1.25 amps. DC output; 70 to 350 AC input volts rms. Request **Bulletin SR-137A.**

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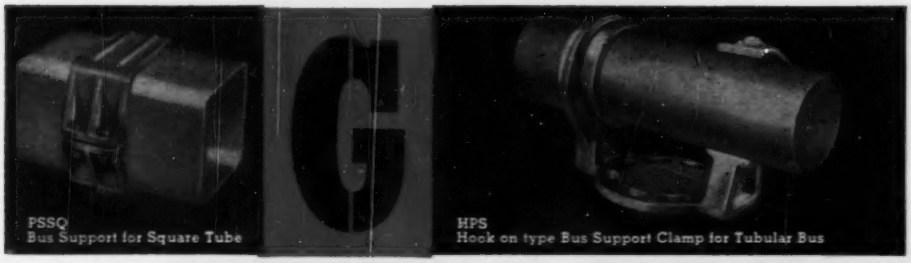

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- Greater durability

These Dossert Bus Supports are made of a high tensile strength cast bronze alloy and are equipped with silicon bronze bolts and nuts, making the entire unit completely non-magnetic. Available for all sizes and types of busses. Dossert Bus Supports can also be furnished in Coupling, Tee Connecting, Elbow Connecting, Tee Coupling and Expansion Connection types.

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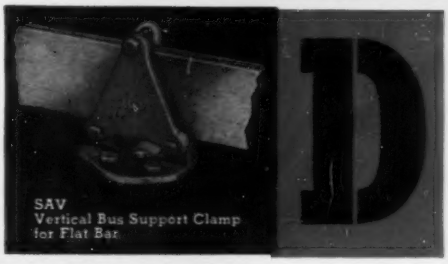

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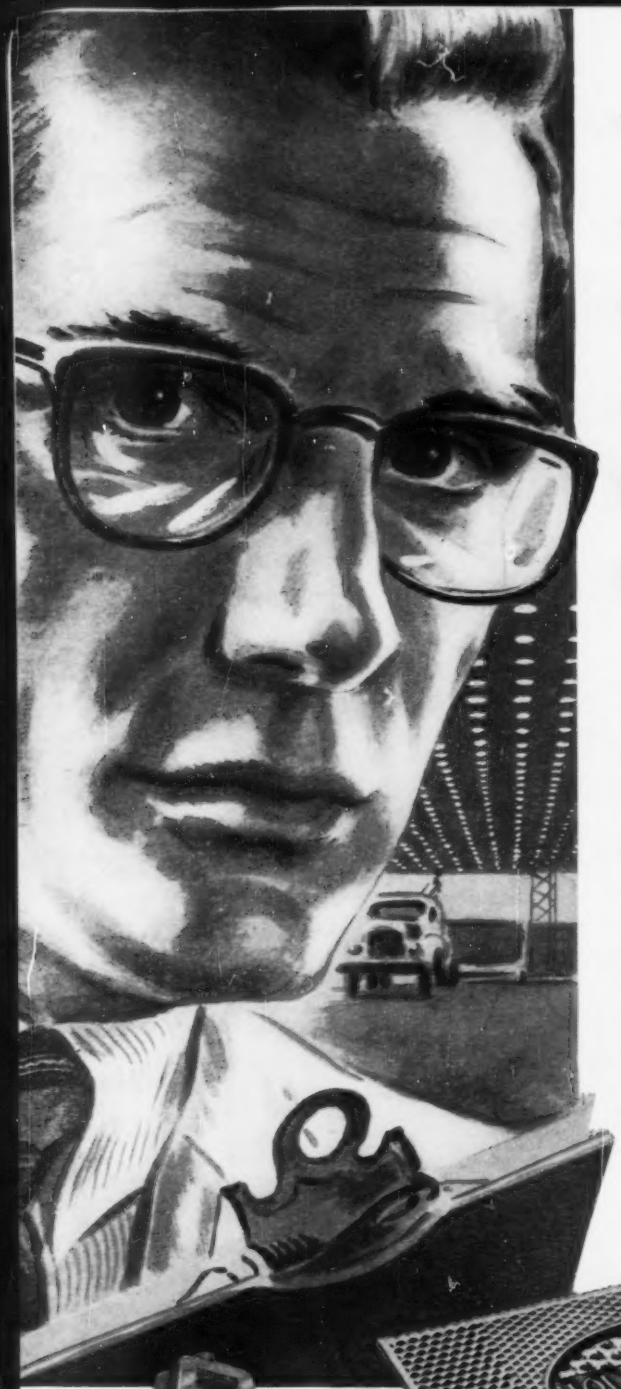

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To be sure of quality . . . look for the name Holophane impressed in each piece

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EFFECT SUBSTANTIAL
USE G&W HI-LO

Looping an existing circuit through a new step-down substation being built created a problem for the Philadelphia Electric Company. The existing single conductor 69kv low pressure oil filled cables could have been cut and extended to the new substation with cables of the same type and by using commercially available joints for the purpose. However, a thorough study of the plan revealed that the use of high pressure oil filled pipe type cables for the new lines would result in substantial savings. The problem: no proven stop joint was available.

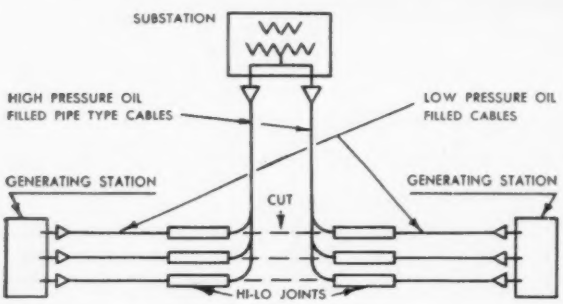
The solution was found in G&W's long experience and complete facilities for designing and manufacturing high voltage cable devices. A successful stop joint to connect 69kv low pressure oil filled cable with high pressure oil filled pipe type cable was produced by G&W collaborating with Philadelphia Electric Company and Phelps Dodge Copper Products Corporation.

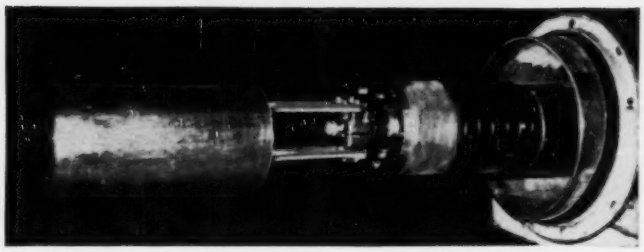
A few months after Philadelphia Electric's installation was completed a large western utility also learned that the HI-LO joint would be profitable to use in its system changes. Installation will be made early in 1958. A HI-LO joint may help reduce the cost of plans you are contemplating for the future. Review them completely. Our cooperation is assured.

TEST DATA—All mechanical and electrical tests proved satisfactory. No evidence of distress, such as carbonization or tracking, was found upon visual inspection and dissection of the joints. Electrical tests in accordance with A.I.E.E. No. 48—Standards for Potheads and High Voltage Time Test of A.E.I.C. Specifications for Pipe Type Cable were as follows:

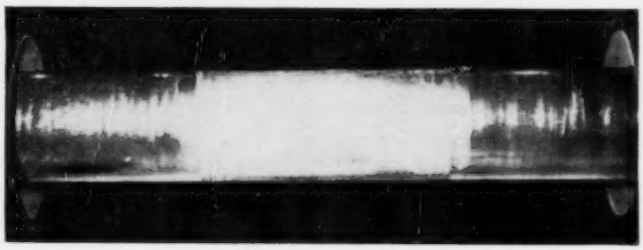
Impulse voltage withstand (350kv required)—OK
60 cycle, one minute withstand (175kv required)—OK
60 cycle, long time tests (97kv required for 6 hours)—OK

a) Withstood 123kv for 6 hours
b) Withstood 148kv for 6 hours
c) Withstood 172kv for 26 minutes—pipe type cable failed outside of joint

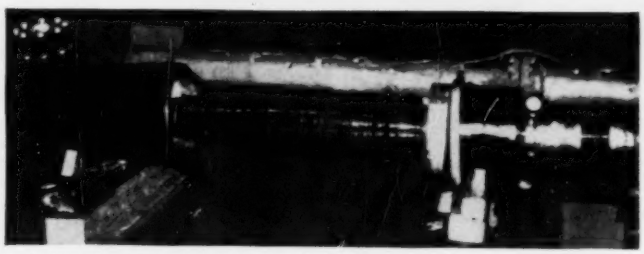




Terminal connectors of the opposing pothead ends are joined by copper straps. This central section is enclosed with a copper sleeve shield which constitutes the high voltage electrode.

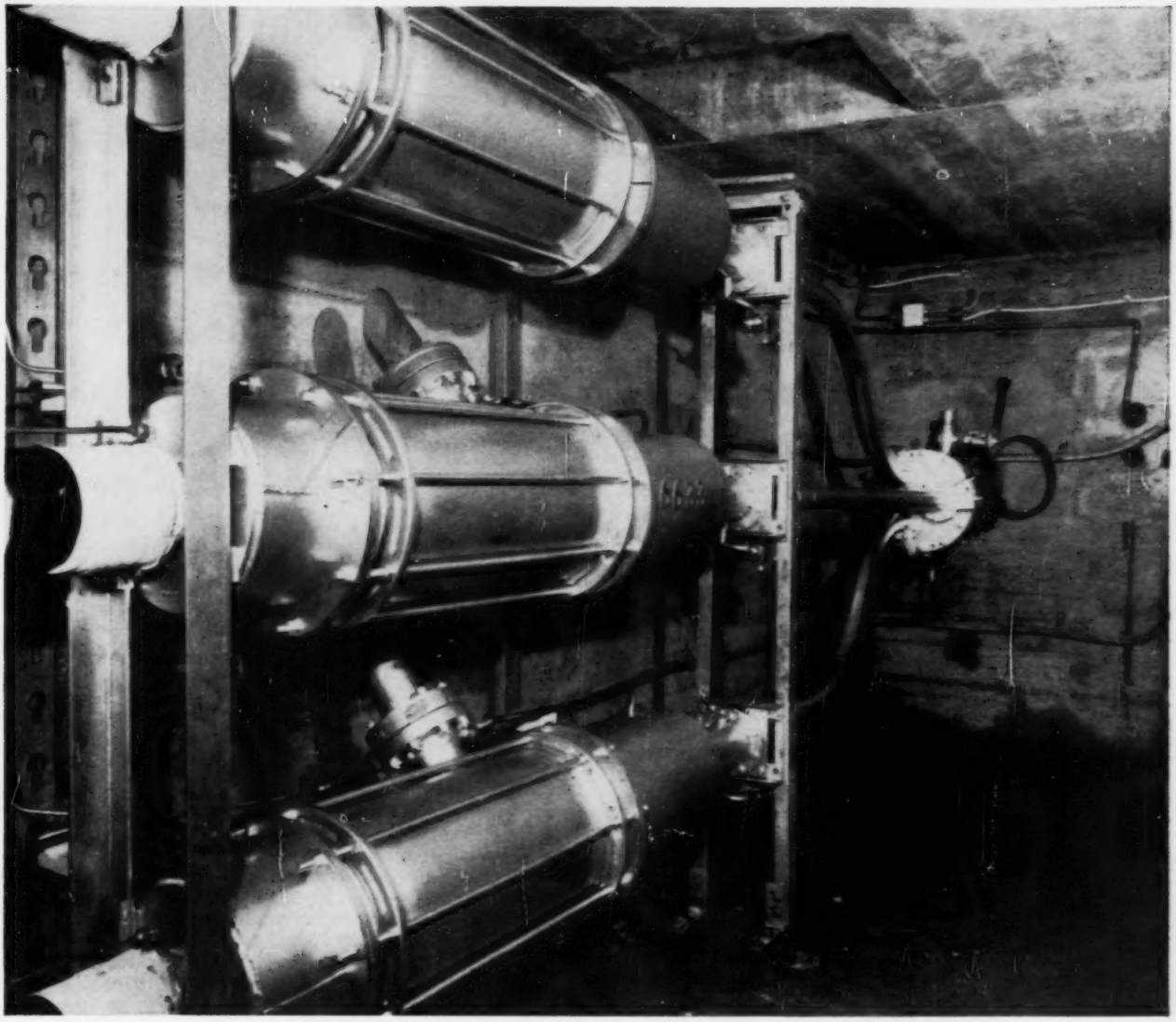


Lucite tubes fit in ends of the copper shield and extend over paper insulated lengths of pothead porcelains. Oil passage to the shield cavity is provided by Tygon tubing spirally wound between crepe paper insulation and Lucite tubes.



Additional crepe paper is applied to a uniform diameter over the Lucite-copper-Lucite assembly for overall joint insulation. Casing may be sealed by welding or by couplings.

SAVINGS.....
PRESSURE STOP JOINTS



Each joint consists essentially of two potheads enclosed in an oil filled non-magnetic steel casing.

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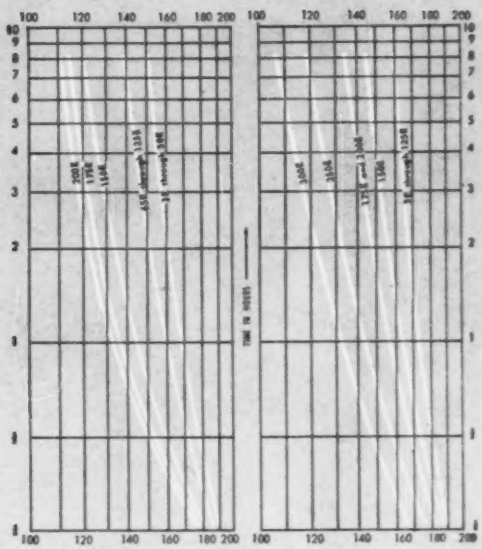
ATJ581

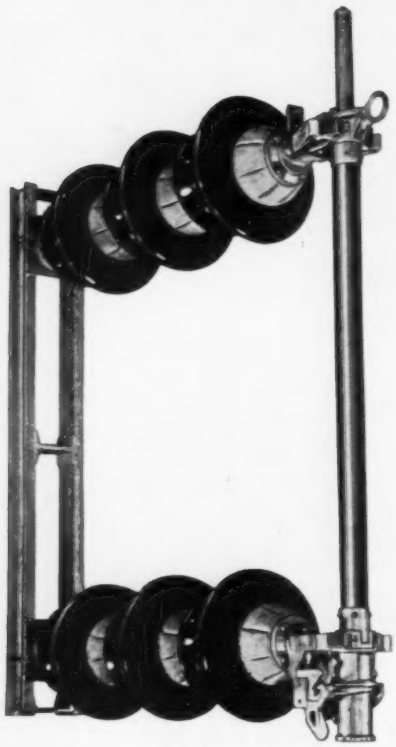
short-time emergency overload capability for SMD Power Fuses



Load Current in Per Cent of SMD-1 Fuse Unit Ampere Rating

Load Current in Per Cent of SMD-2 Fuse Unit Ampere Rating

now... even for overloads you can match power fuses to power transformers



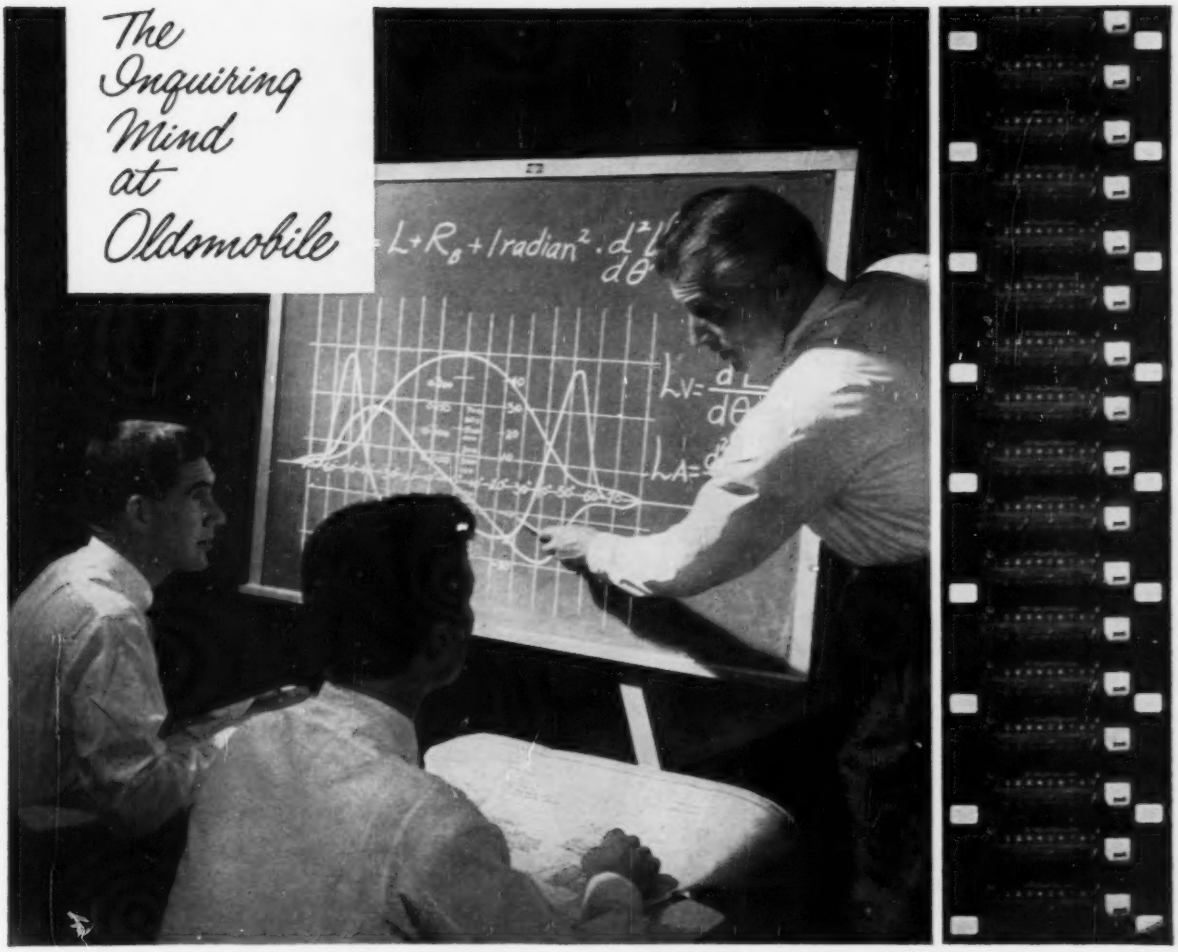
The pressure is on to obtain maximum utilization of power transformer capacity. This pressure has led to precise evaluation of transformer short-time overload capabilities—for both daily peaks and occasional emergencies.

To keep pace, S&C has made correspondingly precise evaluations of the overload capabilities of its power fuses.

The result: (1) New fusing tables (minimum ampere rating recommendation) which recognize short-time daily overload and (2) new curves (see above) which permit you to subject power fuses to extreme short-time overload during emergencies, as when one transformer picks up the load of another.

All of this is part of a new method for power fuse selection contained in a 16-page package—Data Bulletin 262. For your copy, write to S&C Electric Company, 4427 Ravenswood Ave., Chicago 40, Ill. In Canada: S&C Electric Canada, Ltd., 8 Vansco Road, Toronto 14, Ontario.

S&C ELECTRIC COMPANY



no. 1 OF A SERIES

FORMULA FOR A NEW BABY OF OURS

High speed photography helps Oldsmobile engineers translate the theory of camshaft design into practical reality.

Developing the "brains" of an engine—its camshaft—demands engineering skill of a high order, both in theory *and* practice. Advanced techniques of precision measurement guide Oldsmobile engineers in creating a profile design of optimum efficiency.

To determine exactly what happens in a valve train system, movies are taken at speeds up to 15,000 frames per second. The valve train under study is assembled in an engine block and driven by an electric dynamometer at precisely controlled speeds. A vernier scale, silver soldered to the valve spring retainer, is photographed as it moves with the valve's opening and closing.

Essentially, these photographs act as an analog computer. Analysis gives a plot of the actual "lift curve" of the camshaft—the exact linear movement of the valve at each degree of camshaft rotation. It tells at what points the valve opens and closes and also whether the valve lifter is following the cam as it should. This curve, compared to the theoretical lift curve is a definite point for refining to begin—to make sure that design theory will be production practice. With this exact and rapid technique of analysis, as many as 50 experimental camshafts may be tested before a final design is fixed.

The Inquiring Mind at Oldsmobile is never at rest in its attempt to build the best engineered car in the industry. Test drive the '58 Oldsmobile and you'll find it's the finest product in our 60-year history.

OLDSMOBILE DIVISION, GENERAL MOTORS CORP.

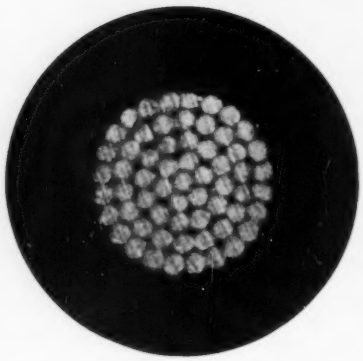
OLDSMOBILE

Pioneer in Progressive Engineering ... Famous for Quality Manufacturing

The radically new, better way to make 15 KV BUTYL-INSULATED CABLE!

ROEBLING

VCV



NEW **V**ERTICAL **C**ONTINUOUS **V**ULCANIZATION ASSURES CONCENTRIC INSULATION. THE RESULT IS UNIFORMLY HIGH DIELECTRIC STRENGTH AND IMPROVED CORONA LEVEL—THROUGHOUT THE LENGTH OF THE CABLE!

Unlike cable cured by other means, butyl-insulated high-voltage cable produced by Roebling's new Vertical Continuous Vulcanization method is never eccentric, abraided, flattened, scored, and its diameter never varies. Conductor is centered *through every inch of the cable.* What's more, the butyl insulation, even in "thick-wall" cables, is dense, free from internal blisters because every foot is cured at the same temperature and pressure. Controlled concentricity, plus uniform dense insulation, gives these cables their exceptional dielectric strength and corona level.

This is superior cable—we don't know how else to say it. For complete information write Electrical Wire Division, John A. Roebling's Sons Corporation, Trenton 2, New Jersey.

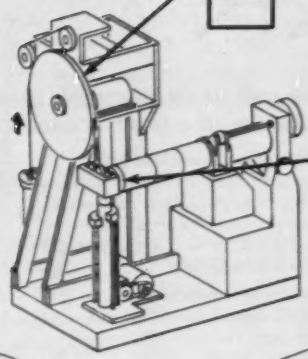
ROEBLING VCV 15KV CABLES are available in a complete range of strand constructions and insulation thicknesses—and with shielding, sheathing and other specifications that exactly meet your requirements.

ROEBLING

Branch Offices in Principal Cities
Subsidiary of The Colorado Fuel and Iron Corporation

Here's how ROEBLING VCV *works!*

2. Conductor is put under controlled tension, which is maintained during entire insulating process.

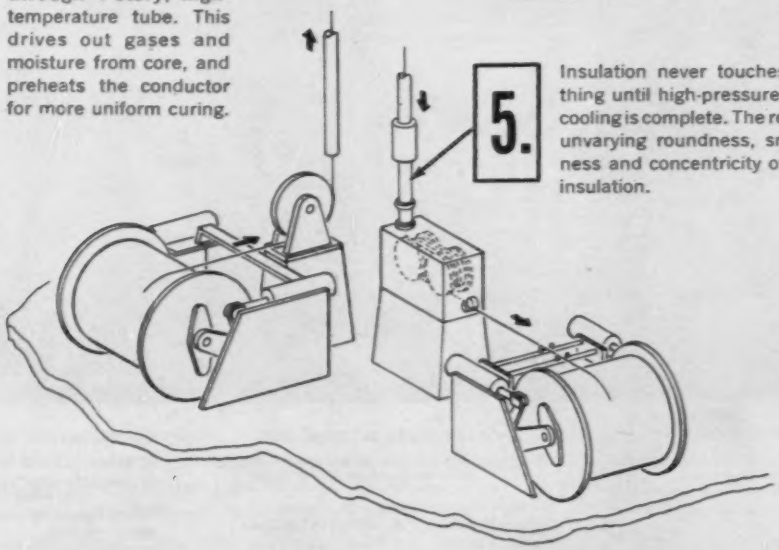


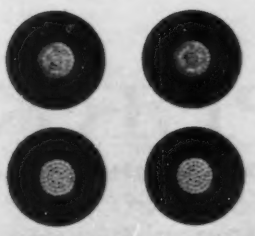
3. Butyl insulation is extruded downward around conductor.

4. Vulcanization takes place continuously and uniformly in vertical tube. Constant high steam pressure assures dense, sound insulation.

1. Strand wrapped in semi-conducting tape goes up through 4-story, high-temperature tube. This drives out gases and moisture from core, and preheats the conductor for more uniform curing.

5. Insulation never touches anything until high-pressure water cooling is complete. The result is unvarying roundness, smoothness and concentricity of butyl insulation.





These samples from a single conductor, 500 MCM cable with 42/64 insulation produced by Roebling VCV method were cut (left to right) at 10, 50, 500 and 1000 ft. intervals. Note how all sections have identical diameter and concentricity. Impartial utilities' experts who examined these samples say they've never seen anything to compare with them for uniformity, roundness, concentricity, smoothness and density of insulation.

An IMPORTANT ADVANCE in DC Power...

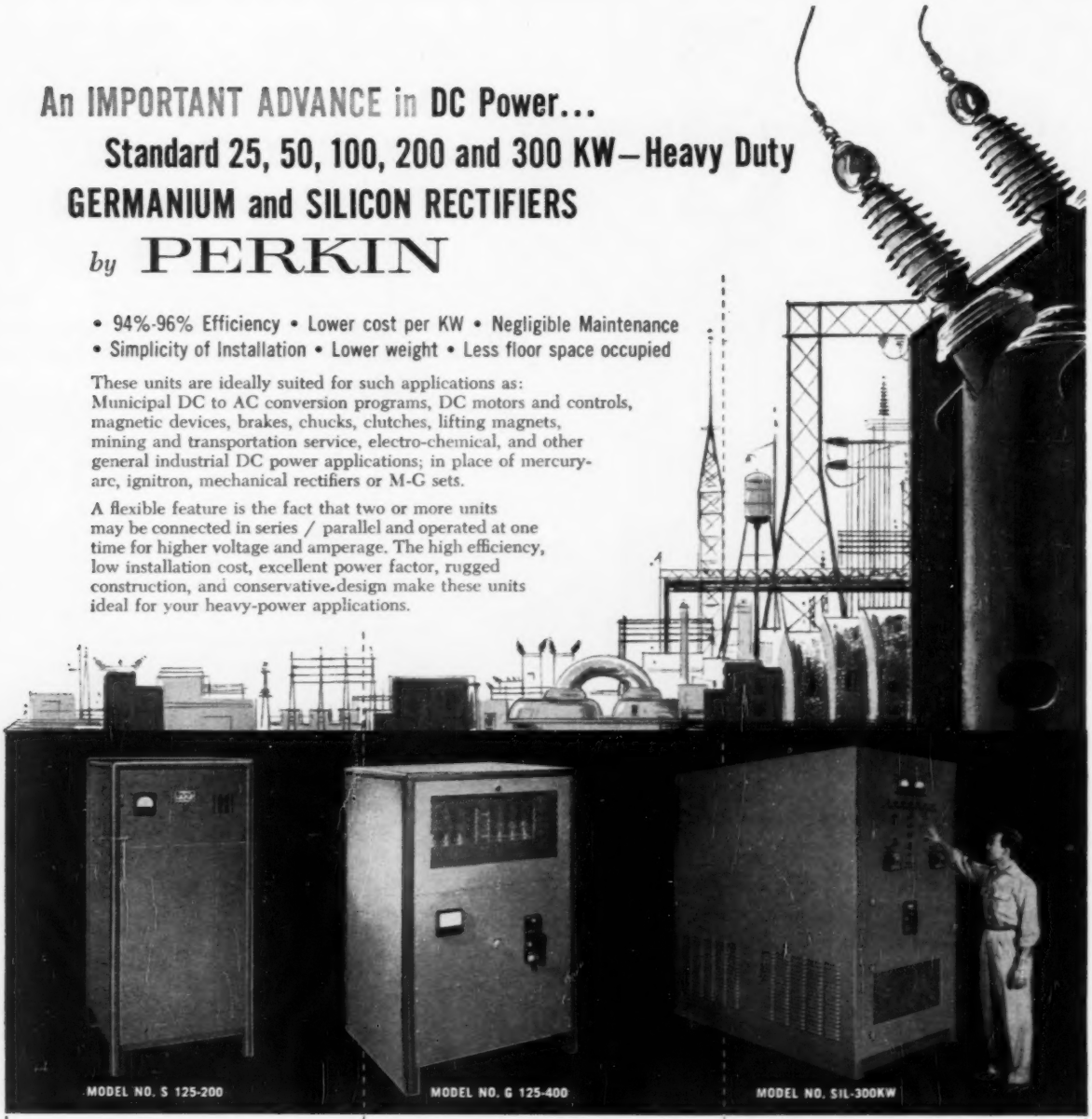
Standard 25, 50, 100, 200 and 300 KW—Heavy Duty GERMANIUM and SILICON RECTIFIERS

by PERKIN

- 94%-96% Efficiency • Lower cost per KW • Negligible Maintenance
- Simplicity of Installation • Lower weight • Less floor space occupied

These units are ideally suited for such applications as: Municipal DC to AC conversion programs, DC motors and controls, magnetic devices, brakes, chucks, clutches, lifting magnets, mining and transportation service, electro-chemical, and other general industrial DC power applications; in place of mercury-arc, ignitron, mechanical rectifiers or M-G sets.

A flexible feature is the fact that two or more units may be connected in series / parallel and operated at one time for higher voltage and amperage. The high efficiency, low installation cost, excellent power factor, rugged construction, and conservative design make these units ideal for your heavy-power applications.



MODEL NO. S 125-200 | MODEL NO. G 125-400 | MODEL NO. SIL-300KW

25 KW SILICON RECTIFIER UNIT

DC Output: 125/250 volts @ 200/100 amperes
AC Input: 208, 230 or 460 volts, 3 phase, 60 cps (per customer specification)
Voltage Regulation: 5% max.; no load to full load
Ripple: 5% RMS max.
Efficiency: 94%
Duty Cycle: Continuous operation at full load, with ambient temperature of 45°C.

50 KW GERMANIUM RECTIFIER UNIT

DC Output: 115-125 volts @ 400 amps available also connected for 62.5 V @ 800 amperes.
AC Input: 208, 230 or 460 volts, 3 phase, 60 cps
Voltage Regulation: 5%; no load to full load
Ripple: 5% RMS
Efficiency: 94%
Duty Cycle: Continuous

300 KW SILICON RECTIFIER UNIT

DC Output: 125/250 volts @ 1200 amps.
AC Input: 460 volts, 3 phase, 60 cps, (2400 or 4160 V also available—please specify.)
Voltage Regulation: 5%; no load to full load
Ripple: 2% RMS
Efficiency: 94%
Duty Cycle: Continuous

100 and 200 KW units, similar in specifications to those above, are also available.

When you require DC power, contact Perkin for a wider range of standard models with prompt delivery schedules. There are over 15,000 Perkin rectifiers in operation in industry today

Contact factory for further data and prices on above units, or send your specifications for prompt recommendations and quotations.

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ENGINEERING PROGRESS – 1957

Reviewed by AIEE Technical Committees

MANY important achievements during the year 1957 have been reported by 30 Committees in the Institute's six Technical Divisions.

In the communication field, the first commercial "over-the-horizon" radio system was placed in service between Florida and Cuba. In addition, there was a significant expansion in the use of electronic devices and methods in toll dialing networks throughout the world. Considerable progress also has been made in both black-and-white and color video tape recording.

Major developments in the field of general applications include numerous improvements in diesel–electric locomotives and the introduction of several new lightweight locomotives. Among the achievements in the production and application of light were transistorized, packaged sources of high-frequency power and the first commercial application of electroluminescent lighting.

In industry, there has been a trend in the direction of more comprehensive controls, wherein the components are blended together into systems capable of performing increasing numbers of tasks that formerly required human skill and judgment.

The instrumentation field has benefited from the continuing miniaturization made possible by the use of transistors and printed circuits. One of the most outstanding features in nuclear instrumentation has been the transition of instruments developed for research to utilization with power-producing reactors.

In the field of power, notable achievements include new approaches to the problem of distance relaying of transmission lines, increased station economies through larger steam generating units, and improvements in conductor insulation, as well as important developments in transformers and rotating machinery.

The year 1957 has seen a number of developments in science and electronics. Analog computers were introduced in the simulation of nuclear reactors and jet engines. The use of digital computers in the electrical industry and utilities has continued to become more widespread. Considerable advancement has been made in semiconductor technology. In the nuclear power field, the year was marked by the completion of several important reactor projects.

Communication

RADIO COMMUNICATION SYSTEMS

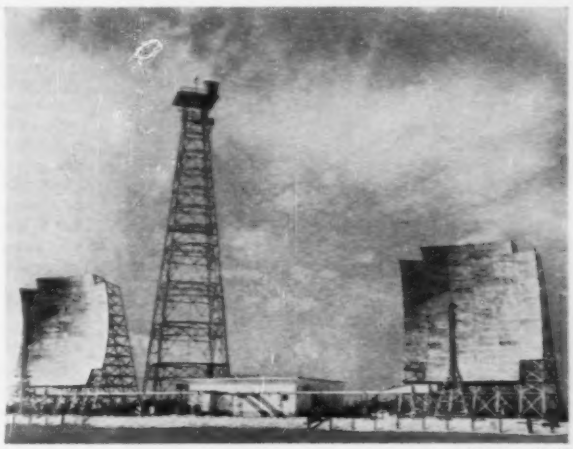
THE FIRST commercial "over-the-horizon" (O/H) radio system in the United States and the first in the world capable of handling a television program or over 200 telephone channels was placed in service on September 12, 1957, between Florida and Cuba by the American Telephone and Telegraph Company and the Radio Corporation of Cuba. The two transmitters at each terminal, which employ 10-kw 6-cavity klystron tubes, were designed by Federal Telecommunication Laboratories (FTL). Each station has two 60-foot square parabolic antennas which are used simultaneously for transmitting and receiving and provide space diversity reception.

This O/H radio technique and FTL equipment have been utilized for the 240-mile San Juan, Puerto Rico, to Ciudad Trujillo, Dominican Republic, link which was cut over for commercial service on November 1, 1957, and for the 6-channel O/H telephone link between Sardinia, Italy, and Minorca, Spain, which was completed in September 1957.

A transportable microwave radio set operating in the 9,000- to 11,000-mc superhigh-frequency band, which can handle eight voice channels using pulse time modulation, has been developed. It can be used for bridging breaks in wire lines during emergencies.

Continued research in microwave telegraph equipments by Western Union Telegraph Company has resulted in about 100% increase in the number of telegraph circuits that can be handled by a microwave radio link. This was accomplished mainly by improving the subcarrier circuit's frequency response characteristics.

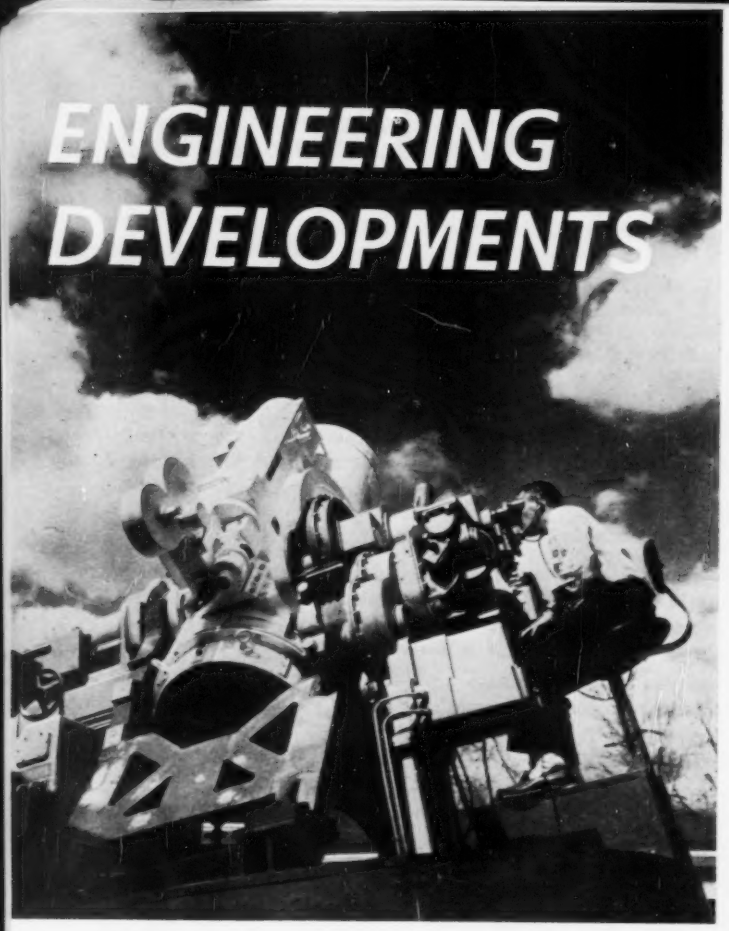
High-speed data transmission has been inaugurated over a number of international radiotelegraph circuits, and will increase the usefulness of large computers and automatic record-keeping machines by making it possible to consolidate information continuously from sources throughout the world.



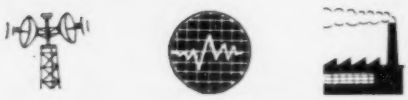
Courtesy AT&T

Over-the-horizon installation at Florida City, Fla., for Florida–Cuba link.

ENGINEERING DEVELOPMENTS



1957



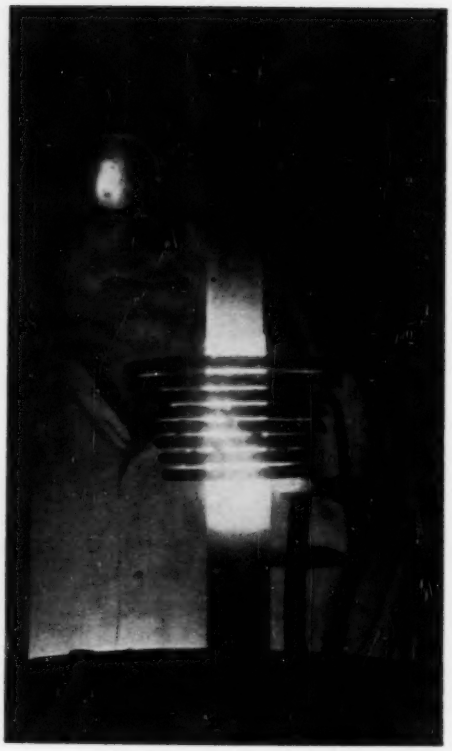
A Photographic Record of Some of the Important Electrical Engineering Achievements of the Year

Official Photograph, U. S. Navy

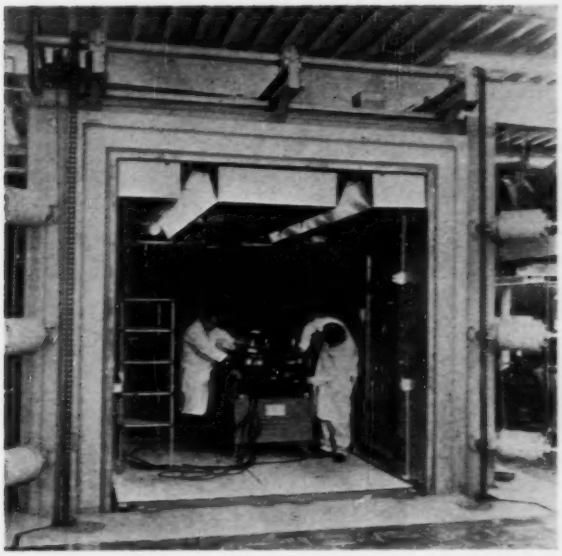
▲ The Perkin-Elmer ROTI (Recording Optical Tracking Instrument), 500-inch focal length missile photographing system, will provide the U. S. Air Force Missile Test Center, Melbourne Beach, Fla., with detailed information on missiles.

◄ Naval Research Lab scientists used this 50-foot radio telescope to "bounce" a 3,000-mc radar signal off the moon on February 24, 1957. Round trip of 500,000 miles was covered by the 2 microsecond pulse in 2½ seconds.

► Westinghouse has developed a technique for the ultrapure preparation of Niobium, rare chemical for future use in rockets, missiles, jet engines, and nuclear reactors. "Cage zone melting" process refines metal at 4,400 F while confining it under a vacuum only four billionths the pressure of the atmosphere.



▲ Giant bank of capacitors being assembled at the General Electric Research Laboratory to produce large amounts of energy in short "bursts" for research program on fusion. Announcement was made that GE scientists at Schenectady, N. Y., have undertaken "a substantial research program" to seek safe and inexpensive power from the fundamental process of the hydrogen bomb. Leading this work on fusion is Dr. Henry Hurwitz (right), shown here discussing instrumentation with Dr. W. F. Westendorp, who has designed much of the experimental equipment required for this study.



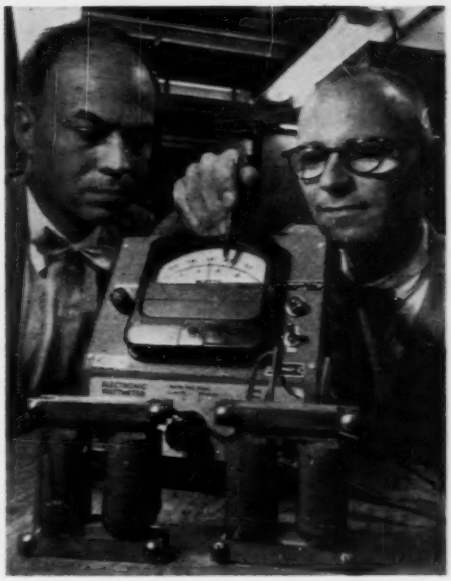
▲ Tenney Engineering, Union, N. J., has supplied Hughes Aircraft Co., Culver City, Calif., with an environmental test chamber having specially engineered doors that slide into the floor out of the way of moving equipment, automatically from the control console. Installed in the Hughes research and development laboratories, the environmental test chamber is in almost continuous operation testing vital electronic equipment for aircraft and radar systems. The giant chamber meets rigorous requirements in temperatures ranging from —75 C to 225 C, altitudes from sea level to 120,000 feet, and a relative humidity ranging from 5 per cent to 95 per cent.

► Design and construction of a medium-power traveling-wave tube capable of amplifying a 500-mc band at a center frequency of about 6,000 mc has been announced by Bell Telephone Laboratories. This tube, the M1789, has a gain of 33 db at 5 watts. Shown, left to right, are C. R. Moster, H. L. McDowell, and J. P. Laico, who participated in its development.

RESEARCH

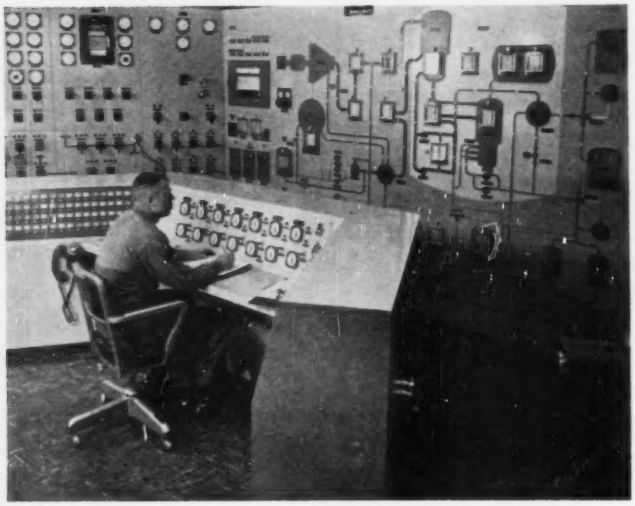
◄ The first successful operation of a completely new solid-state device which will oscillate at microwave frequencies has been achieved at Bell Telephone Laboratories, Inc. One of its outstanding characteristics is that it is expected to have very low noise compared with conventional microwave devices.

► Reduced loss is noted in experimental transformer made with General Electric's new "four-square" magnetic sheet material, when compared with similar transformer made from the best magnetic sheet now in use—a singly oriented material. Even better results should be obtained using the "four-square" sheet in transformers designed to take full advantage of doubly oriented material.



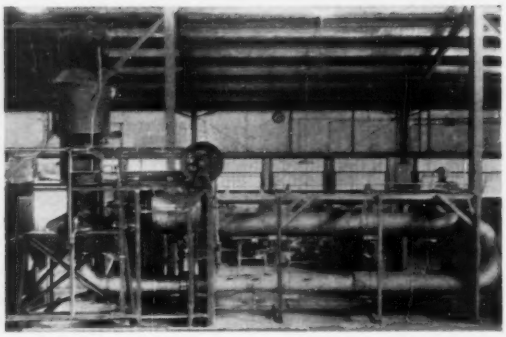
only four billionths the pressure of the atmosphere.

REACTORS

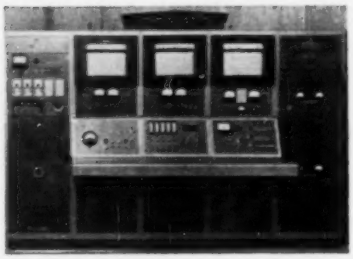


◄ The Army Package Power Reactor is a joint project of the Atomic Energy Commission and the Department of Defense. It is the first nuclear plant for providing power and heat for military requirements in remote areas where conventional fuels are too costly. Design specifies that components must be transportable by air and capable of erection at a remote field site within a six-month period.

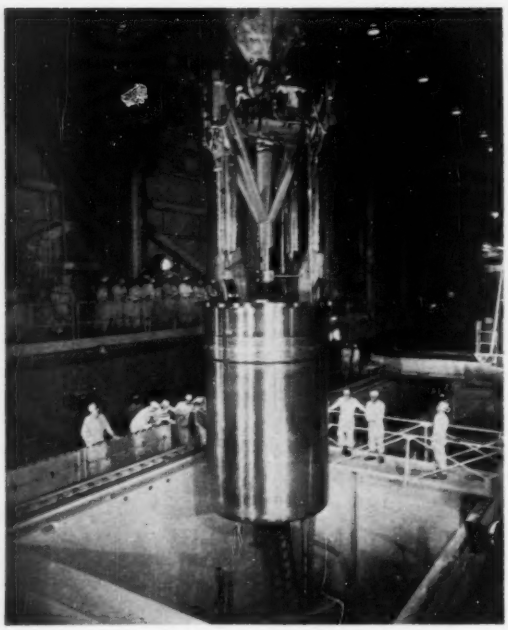
▲ Steel bb's serve as the shielding in a new "hot" cell at Westinghouse materials engineering department's radiation and nucleonics laboratory. Cell has half-inch thick steel walls 15 inches apart. Between walls are 35 tons of bb's—equal to 10-inch steel in ability to contain atomic radiations. Use of bb's makes cell portable because shot can be drained.



◄ Largest hermetically sealed centrifugal pump designed for liquid metal circulation in a nuclear power plant has been built by Allis-Chalmers for the Argonne National Laboratory. The 5,000-gpm, 106-foot head pump unit is driven by a 150-hp, 1,800-rpm TEFC motor specially adapted to maintain an inert gas atmosphere above the liquid metal by confining the gas within the motor housing.



▲ Research reactor control console designed and built by American Machine & Foundry Co. is for first enriched-fuel reactor in western Europe. The Technical University (Munich) console incorporates controls and shows values for rate of change of neutron flux and power level.

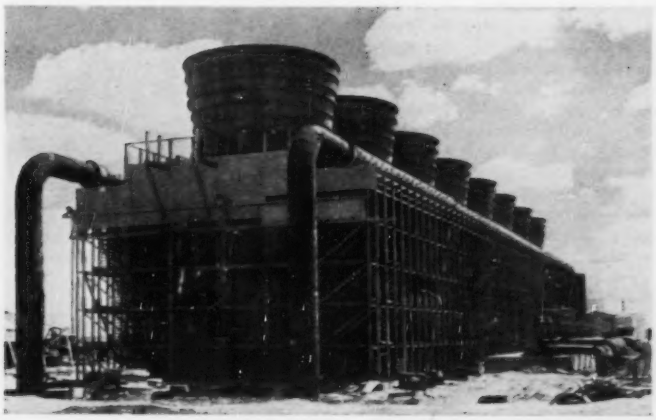


◄ This 58-ton multimillion dollar nuclear core, or fuel charge is slowly lowered into position with its precious fuel consisting of 14 tons of natural uranium and 165 pounds of highly enriched uranium. Nuclear reaction will take place within this core. Duquesne Light Co. will operate the Shippingport atomic power station. Westinghouse under contract to the AEC designed and developed the nuclear reactor.

► Radiation detectors have been developed that keep a continuous record of radiation hazards in the test area after a blast. Information is stored in well-protected underground recorders until area can be entered safely. One type of spotter is designed to pop up from the ground like a periscope a split second after detonation at various distances from the blast. Results of tests may provide radiation combat charts.

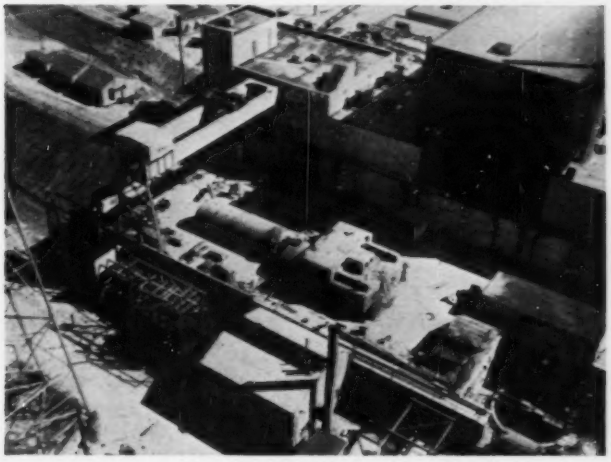
U. S. Army Photograph

terial.

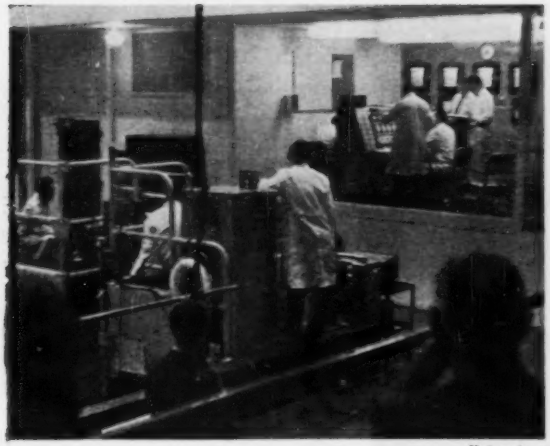


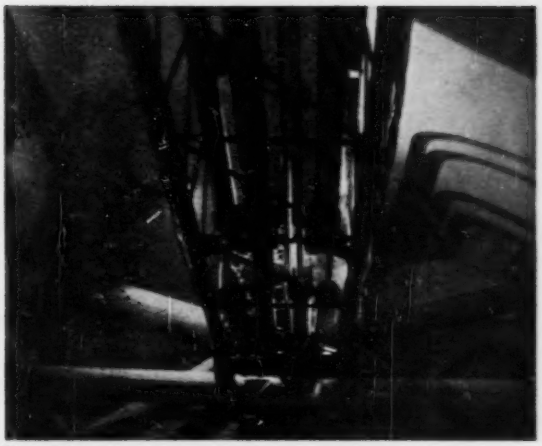
▲ The cooling tower shown, one of the largest ever built, will be used to supply condenser cooling water for the prototype of the large U. S. Navy surface ship nuclear propulsion plant now under construction in Idaho. Designed and developed by the Westinghouse Electric Corporation for the U.S. Atomic Energy Commission, the nuclear power plant will be housed in an exact replica of a ship's hull. Several other buildings will house laboratories, shops, and storage areas.

▲ Dome-shaped reactor building for the PRDC Enrico Fermi Atomic Power Plant stands as a new landmark on the Lake Erie shoreline about 30 miles south of Detroit, Mich. Picture also shows excavation in the left foreground for the plant services building. Pile driving for a sodium treatment and handling building has since begun in the area to right of the reactor building.



◄ The first full-scale nuclear power plant in the U.S., the PWR (pressurized water reactor) at Shippingport, Pa., went into operation in 1957. Shown here is a close view of the turbine-generator set. The plant was designed by the Bettis Plant of the AEC operated by the Westinghouse Electric Corp. It will be operated by and supply power to the Duquesne Light Company.



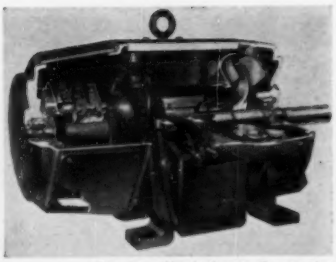


University of Michigan Photographs

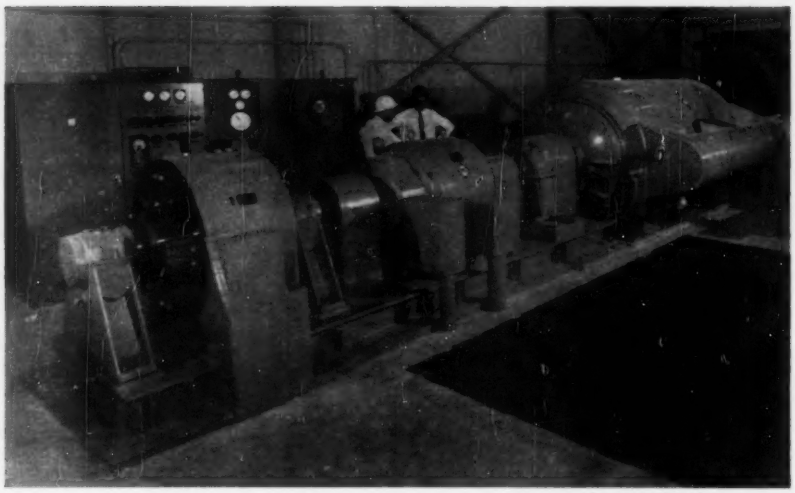
▲ View of control room and bridge of the Ford Swimming Pool Reactor. The movable bridge supports reactor core, control and safety rod drive units, and nuclear sensing devices. (*Right*) Core and beam ports as seen from north end of the pool. The four cylinders in the near edge of the core are ionization chambers which provide control and safety signals to the control room. Long rod in center front edge of core is a fission chamber to obtain information on reactor performance at low power levels.

ROTATING MACHINERY

► Lifeline-H industrial d-c motors and generators depart from traditional design in the use of a high-temperature silicone insulation system rated for operation at Class B temperatures, a controlled ventilation system in which cooling air is drawn from the drive end and expelled at the commutator end, and a new housing construction for applications requiring splashproof construction.

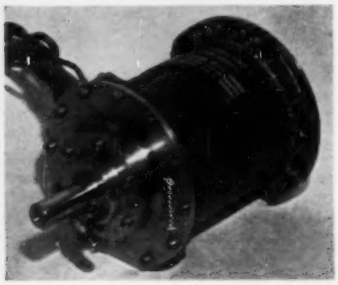


Courtesy Westinghouse Corporation



Courtesy Allis-Chalmers Corp.

▲ Outstanding results from a new type synchronous condenser were reported from a southern steel mill. The unit, was installed to reduce light flicker resulting from arc furnace operation. Rated 30,000 kva (leading) at 1/2 psi hydrogen pressure, 25,000 kva (lagging), 13,800 volts, 3 phase, 60 cycle, the unit operates at 3,600 rpm. At 10 psi hydrogen, the machine capability is 40,000 kva (leading). Both stator and rotor coils are cooled by hydrogen gas flowing at high velocity in direct contact with conductor copper.

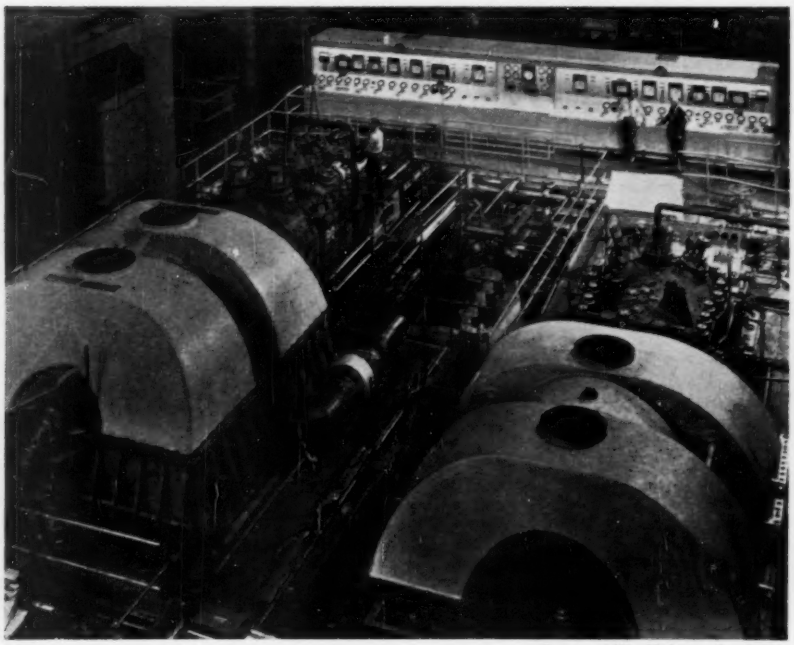


Courtesy American Machine & Foundry Co.

▲ AMF's 48,000 rpm induction generator is a 6-phase, 4-pole machine whose output is rectified to provide 28-volt d-c power. Rated at 3 kw for one application, it is capable of generating over twice this amount of power.

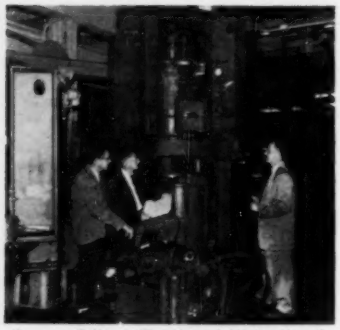
Courtesy General Electric Co.

▲ A NEMA size 0 and 1 magnetic motor starter that is 42% smaller than previous open forms has been developed by GE for machine tools, pumps, hoists, blowers, saws, compressors, mixers, and packaging machines. Starter is of "snap-slide" construction and can be mounted in any position.



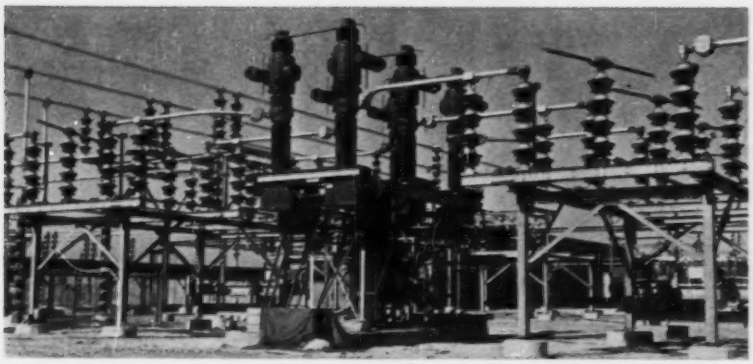
Courtesy Allis-Chalmers Corporation

▲ These 3,600-rpm turbines are of Allis-Chalmers side-crossunder design to drive supercharged hydrogen-cooled generators, rotor supercharged for 100-mw and with supercharged rotor and stater for 150-mw and use 26-inch (*left*) and 23-inch (*right*) exhaust blades.

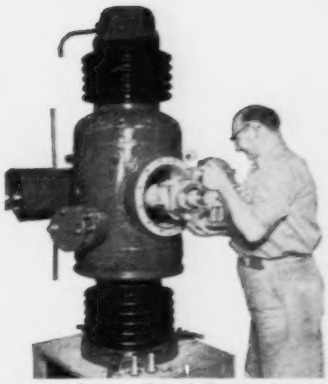


Courtesy Reliance Electric and Engineering Co.

▲ This huge vertical dynamometer has been designed for nuclear aircraft research. The 200-hp, 1,150/2,300-rpm, motors operate through a speed increaser gear unit to produce an output speed of 200-hp, 5,000/10,000 rpm, constant hp.

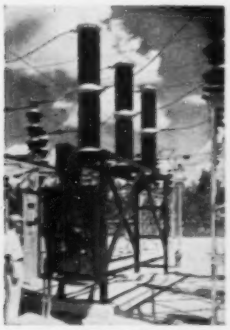


▲ This new 138-kv, 10,000-mva high-voltage airblast circuit breaker built by the General Electric Company's high voltage switchgear department at Philadelphia, Pa., and installed in the Corona Substation of the Consolidated Edison Company of New York, N.Y., features high-speed operation and current transformers as an integral part of the breaker column.



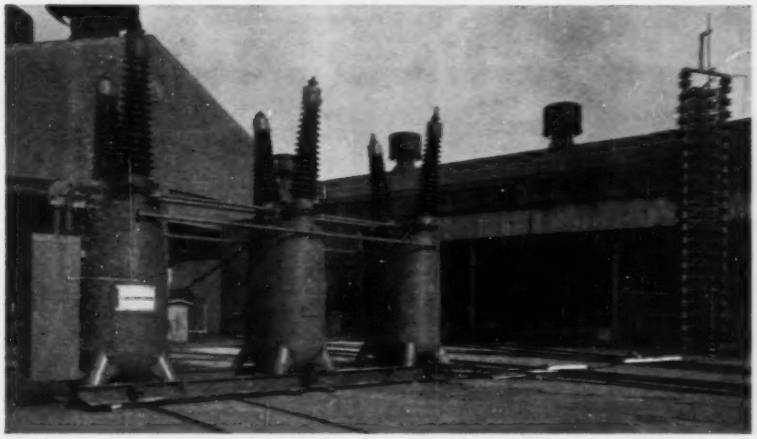
Courtesy General Electric Company

▲ GE's 138-kv, 10,000-mva high-voltage airblast circuit breaker features ease of maintenance and inspection with a combination interrupter and operating element which can readily be removed from the column.



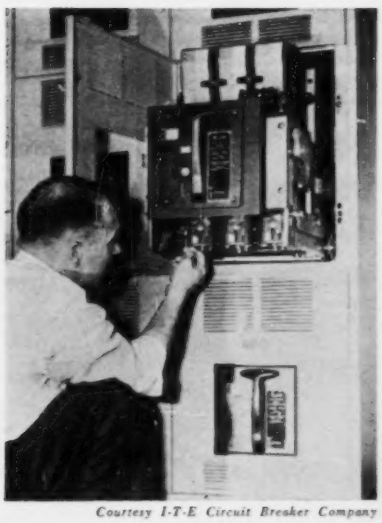
Courtesy Westinghouse

▲ These 115-kv, 1,000-mva gas-filled (SF_6) breakers have a continuous current rating of 400-amperes rms, will interrupt in 5 cycles, and reclose in less than 15 cycles.



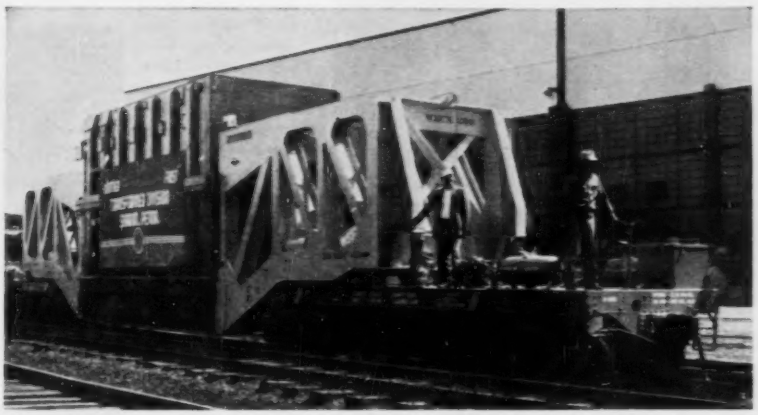
Courtesy Westinghouse Electric Corporation

▲ One normally speaks of ratings being extended upward; but the tubular de-ion grid interrupter, originally designed for the 330-kv circuit breaker, is an exception—its ratings are being extended downward. This same fundamental design has been adapted to 230, 138, and 69-kv Westinghouse breaker ratings. Inside this 230-kva watch case breaker is the new tubular grid interrupter which gives it an increased rating at 15,000 mva.



Courtesy I-T-E Circuit Breaker Company

▲ Accessible trips, on both manual and electrical types, provide a new ease of adjustment. All three trips for this 600-ampere breaker are mounted on a single molding. Trip molding can be replaced in 1/5 the time required for three individual trips.



▲ Three-part railroad car was designed by Westinghouse to carry a 412,000-pound auto-transformer, which serves as the center portion of the car. Two identical 30-foot long end-supporting sections permit center transformer section to be lowered to track level to accommodate taller units.

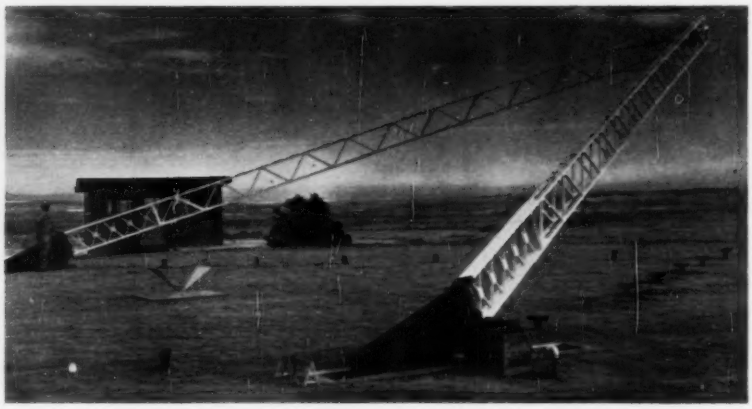
COMMUNICATIONS

Official Photograph, U. S. Navy

▲ Scientists at the Naval Research Laboratory have used the moon as a radio relay station. Using this large antenna formed by scooping a 250-foot diameter hole in the earth, 200-mc radar contact with the moon was obtained. Finding the moon comparatively smooth to radio waves, scientists believe that the moon might serve as a radio relay station. Continued experiments at the same and higher frequencies, which included round-trip transmission of voice messages, now indicate that many types of communication can be carried on via the moon.

U. S. Army Photograph

▲ Long narrow clusters of tiny solar cells on either side of the Army's famous helmet radio provide all the power needed to operate the transmitter–receiver. Teamed with small nickel-cadmium storage batteries for peak power and nighttime operation, the silicon wafer solar cells can supply current for a year compared with dry cell life of hours.

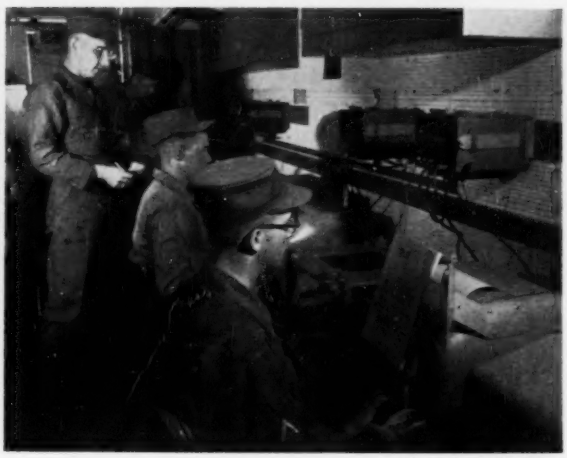


▲ Here is an antenna test range installed at Boulder Laboratories of the National Bureau of Standards to record antenna patterns. A model antenna is placed on the ground in the center of the V frame. By using this model antenna to record signals from a transmitter at the vertex of the V frame while it and the model antenna are rotated, the full three-dimensional pattern of the antenna can be recorded. Model factors as high as 60 to 1 are used together with frequencies as high as 1,500 mc.

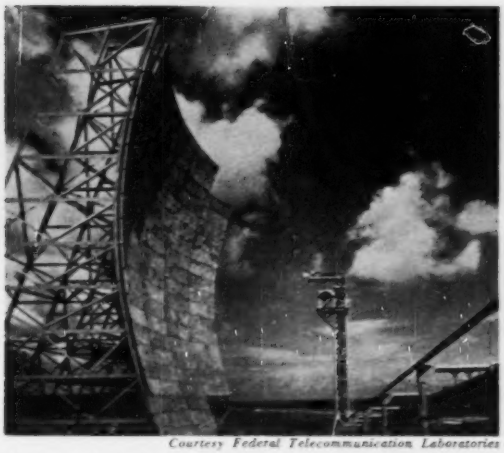
U. S. Army Photograph

▲ Engineers lower metal-encased vacuum tube into U. S. Army's World Spanner, world's mightiest shortwave transmitter. Through single sideband design and a new beam antenna effective power reaches 24 million watts.

► A new vehicle-mounted U. S. Army communications system gives commanders in nuclear-age combat instant control over dispersed tactical support elements. Called the Tactical Support Center (TSC), the system allows a field commander to weld his mobile support forces into a co-ordinated, power-packed team. The need for such centers grew out of the complex nature and rapid movement of modern warfare.



U. S. Army Photograph



Courtesy Federal Telecommunication Laboratories

▲ **Two 60-foot parabolic antennas at Guanabo, Cuba, form the southern terminus of the 185-mile Florida–Cuba over-the-horizon (O/H) microwave link. Dual polarized feed horns mounted in front of the reflectors permit each antenna to receive as well as transmit signals.**

Courtesy Bell Telephone Laboratories

▲ **An experimental device called a data subset makes possible the transmission of printed material over telephone lines at a speed of about 1,000 wpm. Information in the form of magnetized spots is stored on magnetic tape by electronic computer, electric typewriter, etc., as shown.**

Courtesy Allen B. Dumont Laboratories, Inc.

▲ **"Dial-Direct" mobile two-way radiotelephone system is the first to allow phone calls to and from vehicles to be relayed, completely unattended, through local telephone companies.**

► **New pushbutton dial radiotelephone for automatic exchanges has been developed for the Rural Electrification Administration. Control head shown is for use in home of rural subscriber. System avoids the uneconomical cost of installing and maintaining telephone lines in sparsely populated areas.**

Courtesy Motorola Inc.

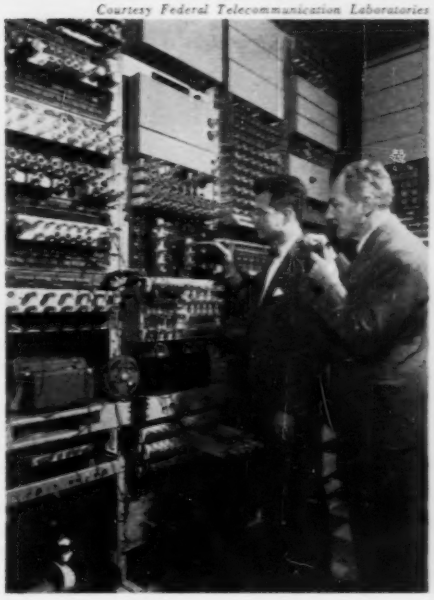
◄ **Motorola's compact transistorized "Dispatcher" radiophone is easily mounted on the handlebar of 2-wheel motorcycles. Current drain on "standby" is only one ampere. Maintenance is minimized by a transistorized switch circuit in the power supply in place of the troublesome vibrator and by the use of modular construction. Foldout design of modular sections provides "both-side" access to all stages.**

Courtesy National Bureau of Standards

◄ **Model C-4 ionosphere sounder of the Boulder Laboratories of the NBS measures heights and movements of the layers as well as their radio reflecting properties in detail. Four such units are operating at Antarctic stations for the IGY. They scan the radio spectrum from 1 to 25 mc every 15 minutes with a 10 kw peak pulse.**

► **An advanced electronic toll-ticketing system for long-distance subscriber dialing has been installed at Amherst, Virginia, for Central Virginia Telephone Company. It records on paper or magnetic tape all information necessary for billing of subscriber-dialed long-distance calls. When processed the tape produces a standard business machine punch card for accounting purposes.**

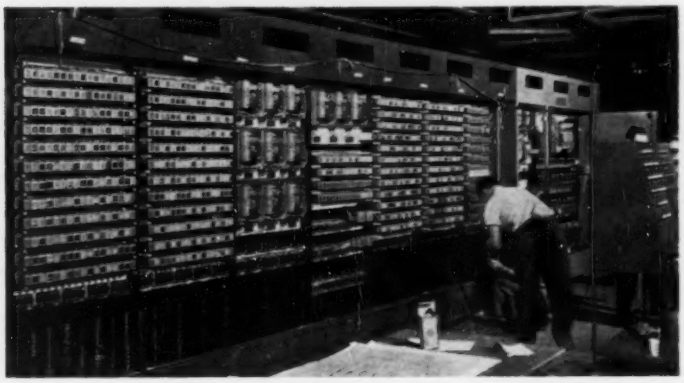
Courtesy Federal Telecommunication Laboratories



COMPUTERS

Courtesy Ford Instrument Company

▲ Automatic navigation computer for tanks and other vehicles to enable military vehicles to travel over deserts and in arctic wastes and find their way to destination. The computer gives not only present position, but course and direction to destination.



▲ One of the largest General Electric static control equipped panels to be built undergoes electrical testing prior to shipment for use with transfer machine in automotive plant. The advantages of increased reliability, long life, and easier maintenance of static control is fast being recognized for equipment-control systems. The new development is a method of electrically controlling machine functions by the use of logic elements and accessories that are not subject to wear and erosion. Logic elements perform the same functions in static control that relays do in conventional control

◄ RCA's BIZMAC electronic data processing system has reduced months of paper work to minutes of push-button operation at the Tank-Automotive Command headquarters in Detroit. It keeps track of more than 100 million facts about the U. S. Army's vast inventory of tank and automotive spare parts throughout the world. The computer is one of some 220 units of 19 different but fully integrated types of equipment in the $4.1 million system. Watching the computer console of BIZMAC are RCA and U. S. Army officials.

Courtesy Minneapolis-Honeywell Regulator Company

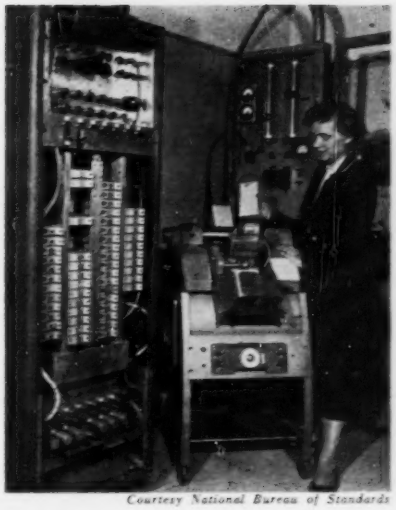
◄ Similar in looks to a huge cribbage board, this electronic unit, called a digital potentiometer, is the nerve center of an advanced data handling sytsem which translates industrial data into language both humans and electronic "brains" can understand. This unit can spot changes as minute as one part in 4,000, measure such things as temperature, pressure, flow, viscosity, and vibration. The pinboard functions like a telephone switchboard to preselect and measure specific data.

▲ A high-speed digital computer called "Leprechaun," not much larger than a home television set and requiring less power to operate, has been developed at Bell Telephone Laboratories. Leprechaun uses only about 9,000 electrical components and more than half of these are transistors. An outstanding feature of this computer is its flexibility; its components can be connected and disconnected easily. It also contains a transistor-driven "random-access magnetic core memory."

Courtesy International Business Machines Corporation

◄ Time card shown being inserted in IBM 8200 Time Punch is punched by machine to indicate employee attendance data, then is fed directly to IBM electric accounting machines for automatic payroll reports. Time Punch will save 10 hours a week in processing 1,200 attendance cards.

► A punched card transcriber, designed by the NBS to convert numbers and instructions recorded on punched cards into a binary serial code, enables more rapid feeding of data into an automatic computer. The system is about 150 times faster than the present paper tape inscriber and can handle up to 600 cards per minute.



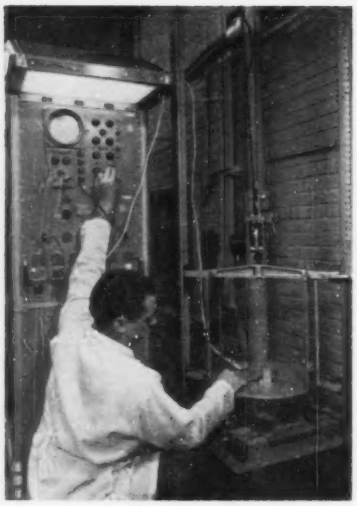
Courtesy National Bureau of Standards

► Operator checks arithmetic unit of International Business Machine's (IBM) new 610 Auto-Point computer, a powerful desk-side machine that can solve many of the problems now being handled by large-scale electronic computers. An outstanding feature of the machine is automatic positioning of the decimal point. Results of computation are printed out by an IBM electric typewriter, center. The 610 can be employed to solve a wide variety of problems, ranging from actuarial calculations to the computations encountered in the design of a jet plane.

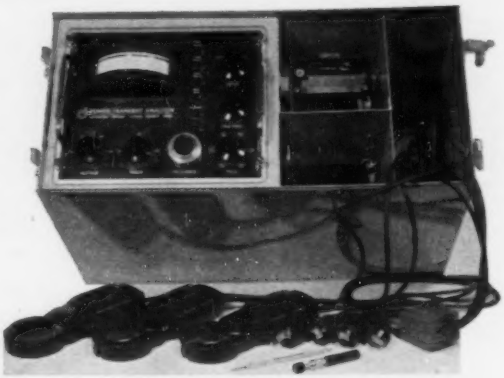
▲ A prerequisite in the development of facilities for the interconnection of computers is an accurate instrument for the measurement of "bit" length and timing. Western Union's distortion measuring instrument indicates signal fidelity at speeds corresponding to 7,000 characters a minute.

▲ RCA's Airborne Systems Laboratory has computers, a replica of a jet aircraft complete with operating controls, and other devices to enable engineers to forecast with electronic precision the nature of airborne systems needed to meet specific aeronautical goals.

INSTRUMENTS

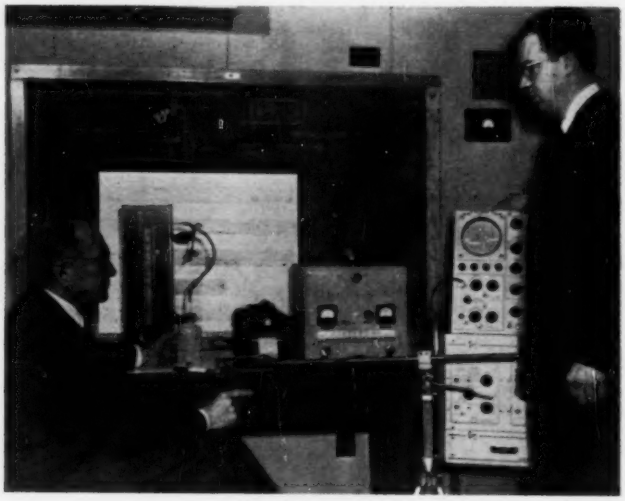


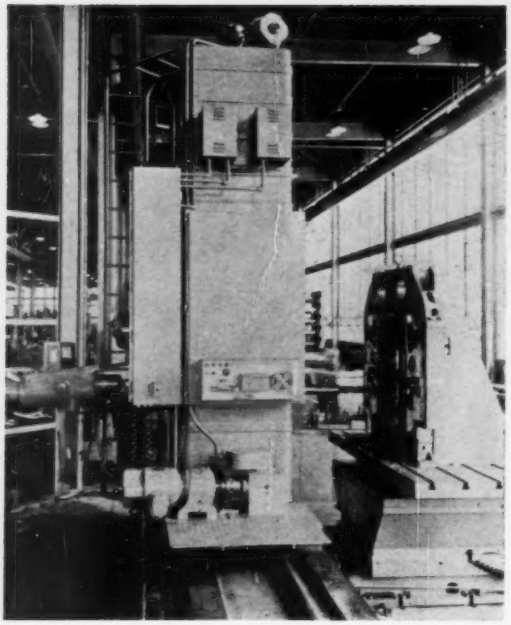
◀ The Memo-Scope 103 oscilloscope, manufactured by the Advanced Electronics Manufacturing Corporation, is illustrated in this rack-mounted environment applied to accelerometer calibration prior to conducting shock measurements at Hughes Aircraft Company, Culver City, Calif. Single or successive "drops" may be displayed on the viewing screen of the instrument for any length of time that may be required for effective examination.



▲ The model TA-120A power transient analyzer is a compact instrument that measures, displays, and records power plant output voltage, frequency, and load under both steady-state and transient conditions. Developed and produced by the American Machine & Foundry Co., the instrument records data by means of a direct-writing oscillograph.

◀ For measuring as little as one ten-thousandths of an inch of paint film, electroplating, or metal overlay, this new instrument, the Laminage, is being tested by General Motors research staff. Left to right are E. A. Hanysz, Dr. R. L. Saur, and C. E. Quinn of the physics and instrumentation department, with Mr. Quinn moving the instrument's probe on the bearing surface overlay. The overlay thickness measurement is registered on the instrument's gauge in front of Dr. Saur.



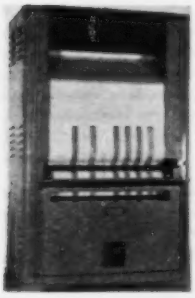


◀ A view of the Kaukauna Machine Corp. model 3040 floor-type horizontal boring, milling, and drilling machine with tape-input mechanism. Accessibility and simplicity of tape reader permits insertion of tape in 2 minutes. Tape unit and manuscript provide operator with zero offset and set-up instructions, automatic precision location of each machining operation, feed, speed, hole size, operation number, depth of hole, plus other pertinent information. In addition, the machine automatically unclamps, moves to location, and reclamps without operator attention. (Above) The "radio pill," developed and tested jointly by the Rockefeller Institute, N. Y., Veterans Administration Hospital, and RCA, translates pressures inside the body's gastrointestinal tract into radio waves which are recorded automatically. FM signals from the pill are picked up by the antenna at the end of a long metal rod and recordings appear on a cathode-ray oscillograph.

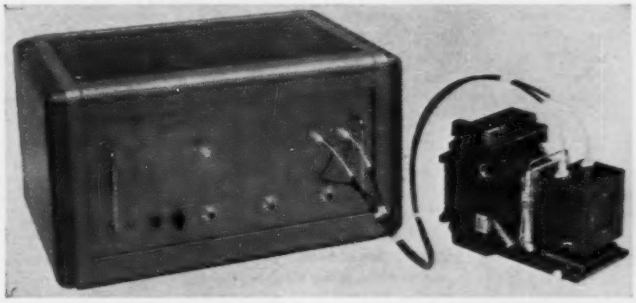
▲ An electronic unit for balancing automotive engines at the end of the assembly line has been developed by the General Motors research staff. Known as a pulse synchronized unbalance indicator, it is now being used for detecting and correcting engine unbalance to lower limits than were possible before.

Official Photograph, U. S. Navy

▲ Carbides in steel and foreign matter in minerals can be analyzed now with an electron probe microanalyzer developed at the U. S. Naval Research Laboratory. Chemical constituents of an area as small as 1/50 the diameter of a human hair can be broken down by focusing a beam of electrons to a small crossover.



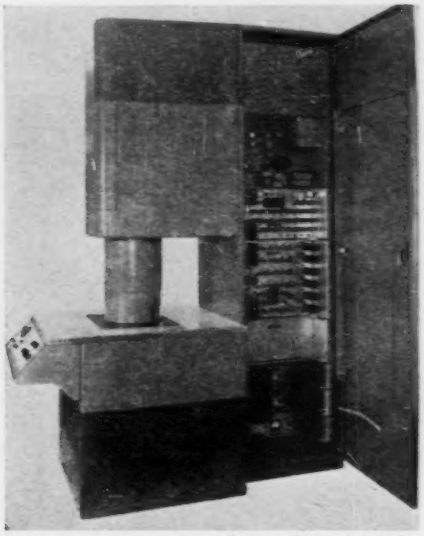
▲ The *RX-48*, a development of Hogan Laboratories, presents performance of up to 450 circuits graphically.



▲ Shutter speeds as fast as 0.1 microsecond are being obtained by the model D20 Kerr Cell camera developed by Electro-Optical Instruments, Inc., Pasadena, Calif. The unit uses a large-aperture hermetically sealed Kerr Cell shutter which can be synchronized to within 2 millimicroseconds or less. The unit operates from 115 volts a-c.

▲ The Weston model 6801 circular chart potentiometer recorder incorporates a 12-inch chart with straight time co-ordinates for accurate readability.

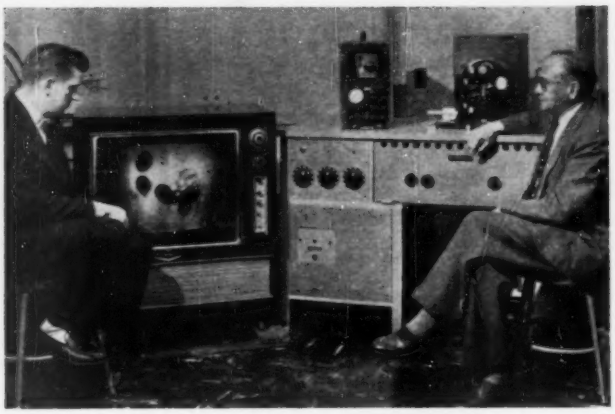
▲ Shown is one of three r-f voltmeter consoles developed by the NBS Radio Standards Laboratory to calibrate all types of voltmeters. Twelve discrete frequencies to 700 mc are used, and all practicable voltage levels of 0.2 volt and higher are available. Reproducibility is 1% or better over a period of 1 year or longer.



Courtesy Philco Corporation

▲ EXICON X-ray viewer uses TV techniques as primary functions of performance. A flying-spot CRT producing a bright spot is focused by lens system on the X-ray negative being examined.

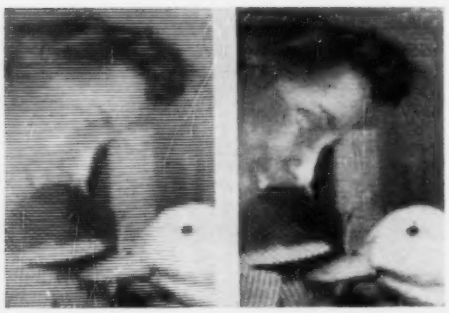
TELEVISION



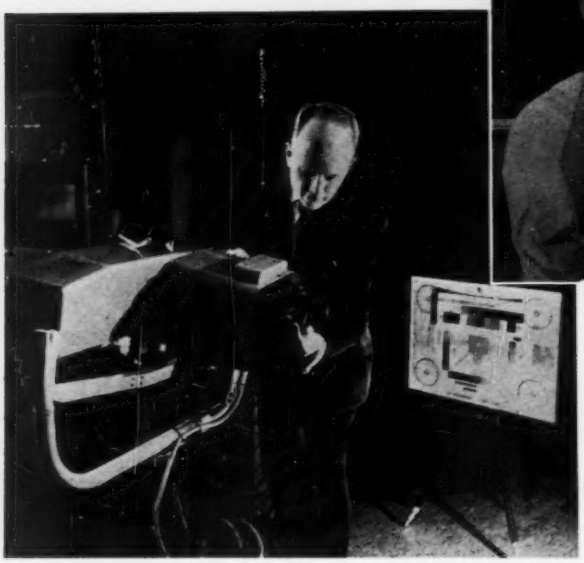
▲ An ultraviolet color-translating television microscope was developed recently at the Rockefeller Institute, New York, N. Y., which will enable scientists to study more effectively the function, structure, and chemistry of living cells. Shown at the left is Fred L. Hatke, electronics engineer, and at the right, Dr. Vladimir K. Zworykin, Rockefeller Institute Affiliate and honorary vice-president of the Radio Corporation of America.

Official Photograph, U. S. Navy, Courtesy TV Guide

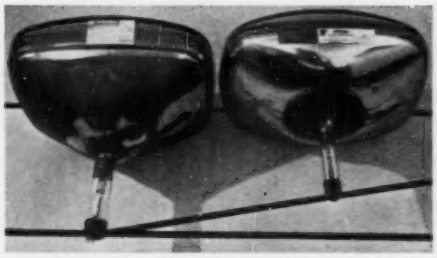
▲ A new transparent television screen has been developed by Dr. Charles Feldman of the United States Naval Research Laboratory. The screen provides a simplified approach to daylight viewing and color television. Dr. Feldman is shown comparing a conventional picture tube *(left)* and a tube containing a transparent screen *(right)* under bright lighting conditions.



◄ Elimination of dark horizontal lines in a television picture could be a step toward larger-sized home screens. A Westinghouse technique employs a method of wobbling the electron beam vertically as it makes its traces across the picture tube. The slight up-and-down beam motion broadens the white lines carrying picture information and narrows the black lines between.

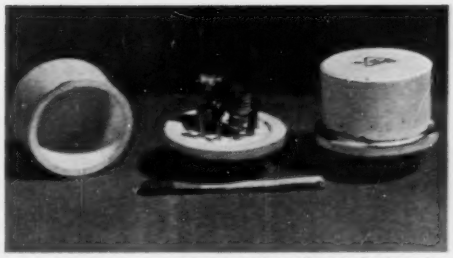


▲ A new type of color cathode-ray tube has resulted from the development of thin transparent films of phosphors by the General Electric Company. This type of tube, called the "penetron," has a face plate coated with two thin layers of phosphor, each capable of emitting a different color. Screen color is controlled by the voltage applied to the electron gun. *(Left)* D. L. Williams of GE's General Engineering Laboratory adjusts the camera of the world's first closed-circuit 3-dimensional color television system. It will be employed for remote viewing work by the company's aircraft nuclear propulsion department at the Atomic Energy Commission's Idaho Falls, Idaho, test site. With the camera installed inside a radioactive area, cables will carry the picture to the viewing screen, located safely behind thick shielding walls.



Courtesy Sylvania Electric Products Inc.

► View of audio beam power amplifier, capable of maximum reliability in high ambient temperatures, can deliver 4.5 watts under class A conditions. Tube makes use of stacked ceramic construction.

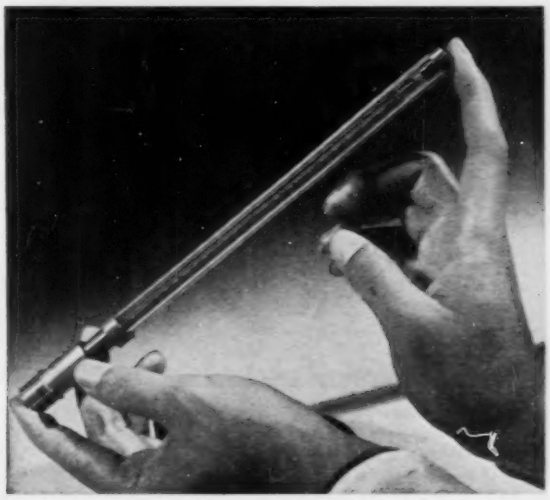


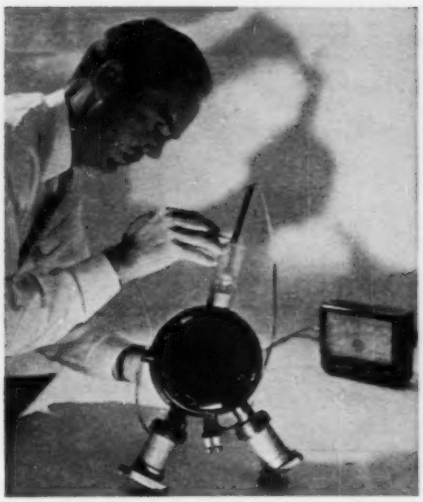
Courtesy Sylvania Electric Products Inc.

▲ Sylvania's entire 1958 TV line will be built around the 110° magnetic deflection picture tube. Tube permits a 50% reduction in cabinet bulk. The 110° tube *(right)* is shorter and lighter than commonly used 90° tube *(left)*. The new, wider angle tube is being produced in 14-, 17-, and 21-inch sizes. Its picture quality and new sets' power have drawn dealers in fringe TV areas.

▼ A traveling-wave tube that may drastically reduce the weight and substantially increase the operating reliability of microwave relay and radar equipment has been developed by RCA. The experimental tube eliminates the need for bulky electromagnetic focusing equipment used with many types of traveling-wave tubes. Photo shows the spiral bifilar windings that form the focusing mechanism, giving the tube a total weight of less than a pound.

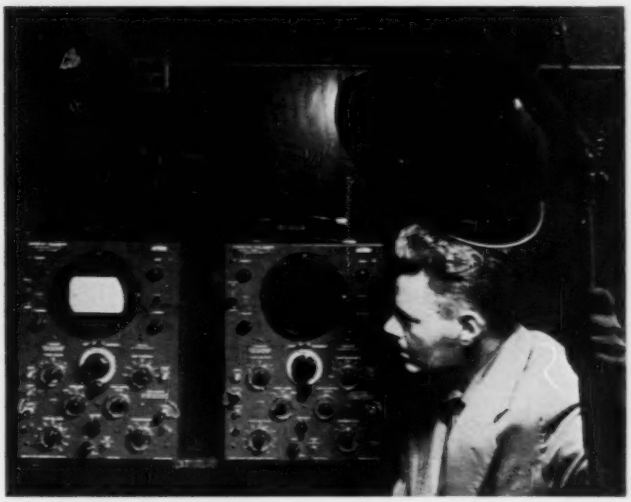
► H. A. Gutzmer, engineer at Stromberg-Carlson, compares the new 5-inch diameter CHARACTRON shaped-beam tube with the older 7-inch diameter tube. The new tube is only 17½ inches long compared with the 40-inch length of the 7-inch diameter tube. The CHARACTRON functions as a radar tube and a tube displaying characters by means of time sharing —the characters are printed on the phosphor screen at a rate of 20,000 a second and retained by the phosphor while the device does its radar work in-between letters and numbers.





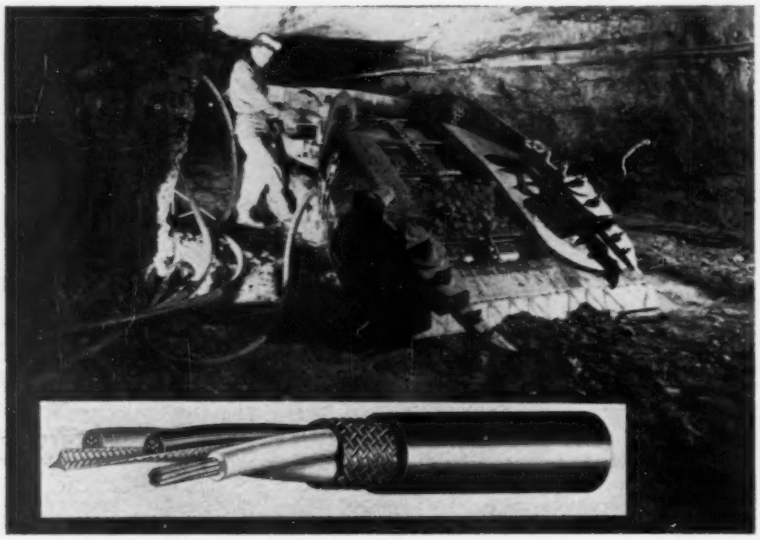
U. S. Army Photograph

▲ This amplitron tube with twice the power efficiency of the magnetron tube will pack more power into the country's radar defense networks. Frank Oakes, Signal Corps engineer, checks tube that was developed by U. S. Army and Raytheon Mfg. Co.

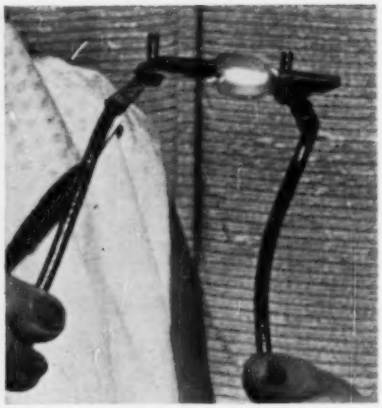


▲ New Du Mont black-background picture screen retains image while standard cathode-ray tube screen at left is blanked out by high powered flood light. Black-background screen has applications for airborne cockpit radar, and for military, industrial, and laboratory equipment which require use in open and other areas with high surrounding light.

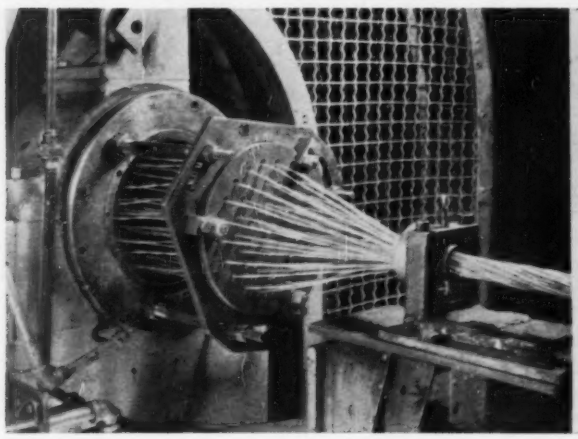
◀ Highly efficient one-piece refractor type outdoor substation unit, designed by the Holophane Company for a 400-watt mercury or 500-watt incandescent lamp, has prismatic refractor of heat-resistant glass. The metal bottom reflector and top cover are made of aluminum. (*Right*) A 200-watt vapor- and dust-tight unit has a prismatic reflector-refractor which provides high output, low glare, and permanence.

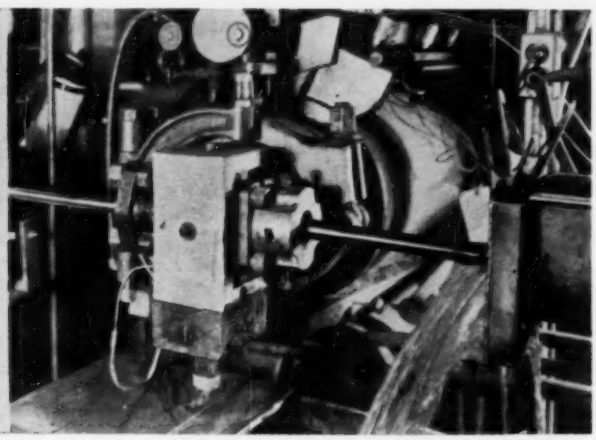


▲ An extra-flexible portable cable with Y-shaped ground conductor has been developed for use in connection with modern three-phase a-c mining equipment. A Y-ground of special copper braid construction is used to separate the three insulated-phase conductors to reduce the possibility of phase-to-phase faults in the event of cable damage. Sufficient conductivity is provided in the Y-ground to trip the machine's circuit breaker without interrupting the main power supply. Photo shows mine loading machine, equipped with General Electric Y-ground portable mining machine cable (*left*) in use in West Virginia mine.



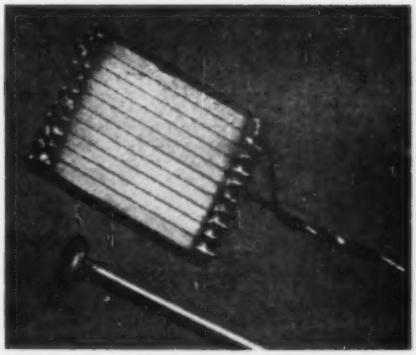
▲ Jet-plane wing-tip lamp is made of quartz and is the size of a stick of chewing gum but is capable of resisting pressures, temperature, and shock of supersonic flying. Development was included in annual Progress Report of Illuminating Engineering Society.



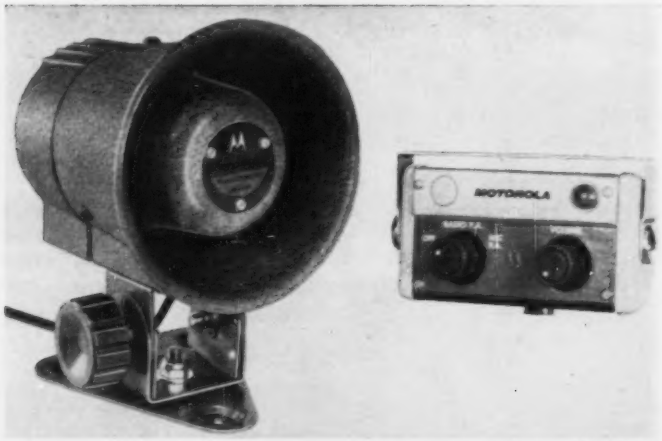


▲ A new type of cable steadily gaining favor with U. S. telephone companies employs lightweight durable polyethylene to do two different jobs performed previously by paper and lead. As both wire insulation and outer cable jacketing, Bakelite polyethylene plays a versatile double role in telephone exchange area cable produced by Whitney Blake Company, New Haven, Conn. Polyethylene's versatility is based on an unusual combination of physical, chemical, and electrical properties. Bakelite polyethylene is moisture resistant and an excellent dielectric. Polyethylene is extruded to form continuous insulation about one sixty-fourth of an inch thick around a single conductor. Pairs of these wires are twisted together and fed through a die that twists 50 pairs together to make a cable core (*left*). A polyethylene tape and then a shielding layer of aluminum is wrapped around the core before the outer jacket of black polyethylene is extruded in place (*right*).

TRANSISTORS

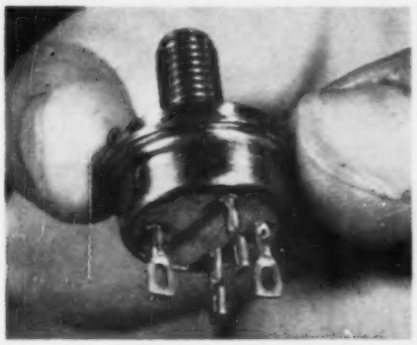


▲ Westinghouse semiconductor device is an infrared detector using the photoelectromagnetic (PEM) effect in a semiconductor material, indium antimonide. The cell, here compared with a straight pin, requires none of the cooling that was necessary for previous photoconducting-type detectors and has both a lower noise figure and shorter response time. Inasmuch as infrared detectors "see" hot objects, this means this device can detect things that are at much cooler temperatures.



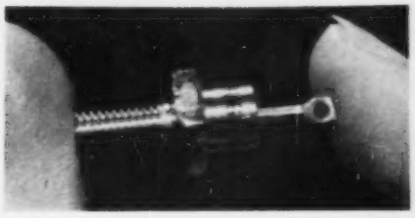
Courtesy Motorola Inc.

▲ Weather resistant, transisterized "Big Voice" speaker gives 2-way radios 15-watt power output when used with 12-volt system. Drivers can hear messages even when hundreds of feet away from vehicles. Preamplifier control box makes it easy to use speaker as separate public address system. Swivel mounting is optional accessory.



Courtesy Minneapolis-Honeywell Regulator Corp.

▲ The first power tetrode in the electronics industry was unveiled at WESCON last summer in San Francisco, Calif. Use of the power tetrode, which is designed for a 28-volt system with currents up to 10 amperes, in a high-fidelity set would reduce the amount of circuitry necessary. The tetrode is also more easily stabilized than existing transistors where thermal runaway is a problem.



Courtesy Hughes Aircraft Company

▲ Hughes power silicon rectifier.

Courtesy Western Union

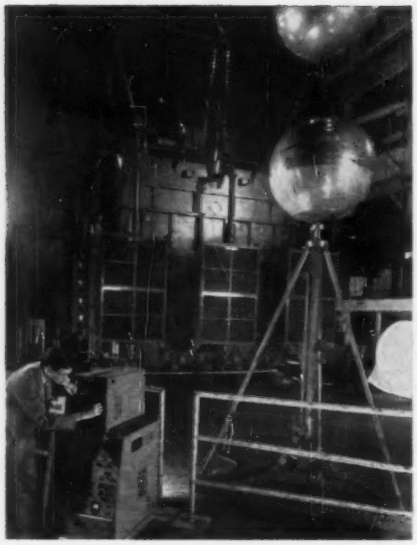
▲ An experimental silicon power transister, capable of providing an output of 5 watts at 10 mc either as an oscillator or an amplifier, has been developed at Bell Telephone Laboratories under the sponsorship of the joint services. Unilateral gain is in excess of 20 db, and a collector efficiency of better than 40% has been achieved. The unit is a p-n-i-p diffused emitter and base transistor, in which a near-intrinsic or "neutral" layer of silicon separates the collector from the other elements. J. T. Nelson *(top)* and J. E. Iwersen of the Bell Labs are shown checking the transistor which is mounted in the special jig in the foreground.

► View of 12-channel electronic distributor for synchronous time-division multiplex operation on high-speed transatlantic telegraph cables. Transistorized equipment, installed at Penzance, England, Bay Roberts, Newfoundland, and Rockaway Beach, New York, transmits up to 600 words per minute over the two connecting cable sections, 2,077 and 1,400 nautical miles in length respectively.

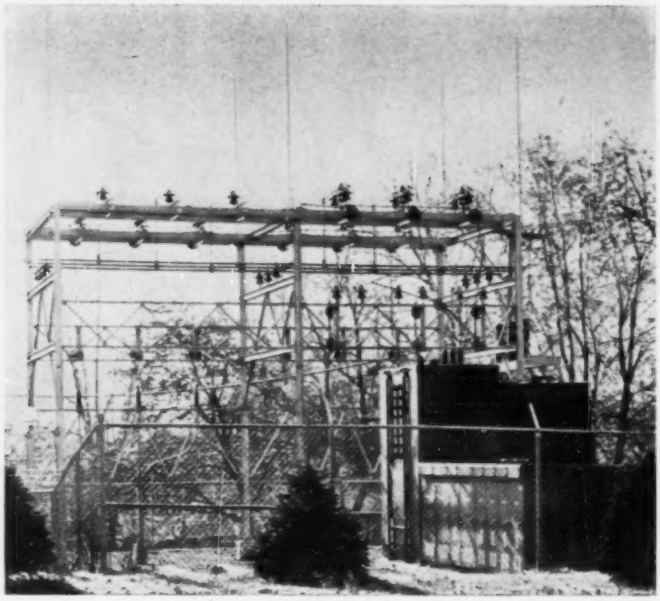
usual combination of physical, chemical, and electrical properties. Bake-

of black polyethylene is extruded in place (*right*).

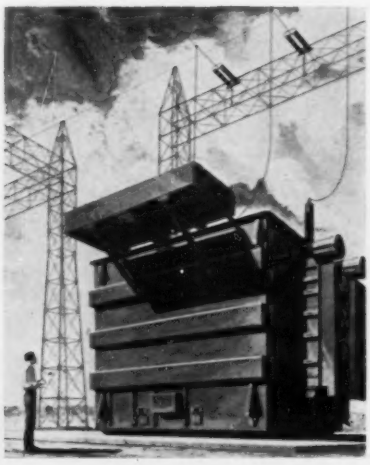
TRANSFORMERS



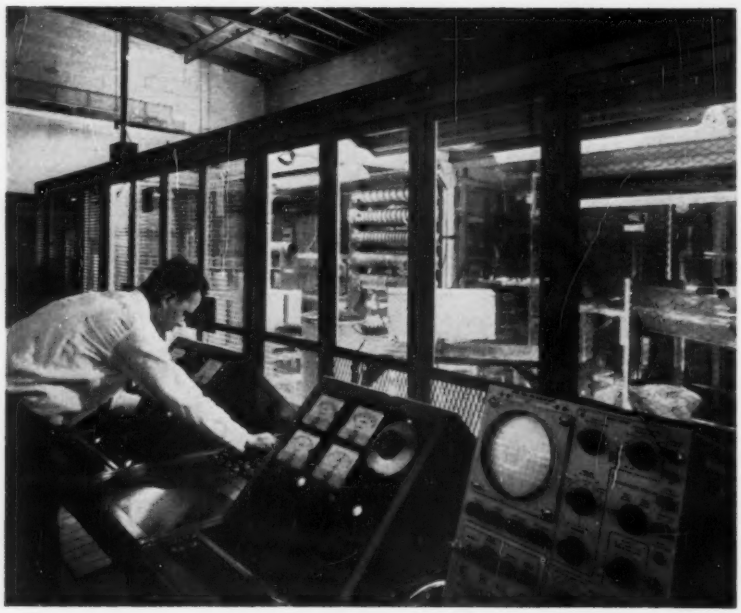
▲ Switching surge test being conducted in high-voltage laboratory of Allis-Chalmers on a new 180-mva, 330- to 138-kv autotransformer. (*Right*) Reductions of 15 to 21 db in audio sound levels of medium and power transformers were achieved in 1957 by GE through use of a new aphonic enclosure, or hood, fitted over main tank.



◀ An acoustico-thermal laboratory for conducting sound and thermal research on transformers up to 10,000 kva has been provided by General Electric at their Rome, Georgia, plant recently.



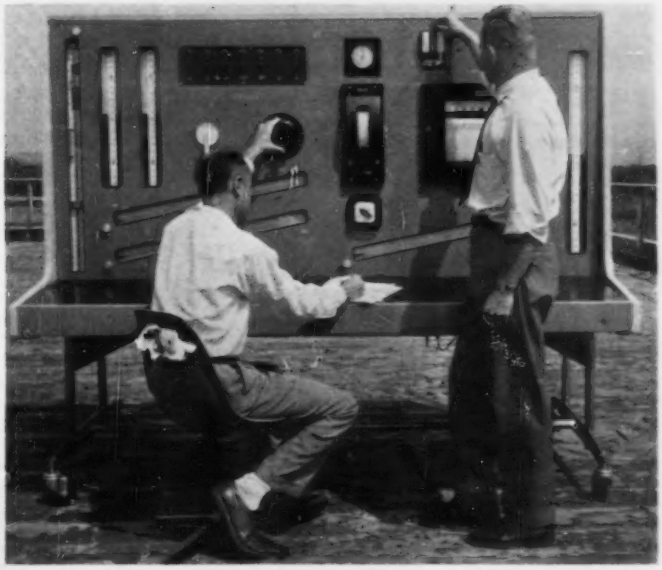
▲ GE's "Atomseal" method of oil preservation for power transformers completely eliminates oil-to-air contact and permits operation at atmospheric pressure. System uses an impermeable air cell that is vented to the atmosphere and floats on the oil in an oil expansion tank.



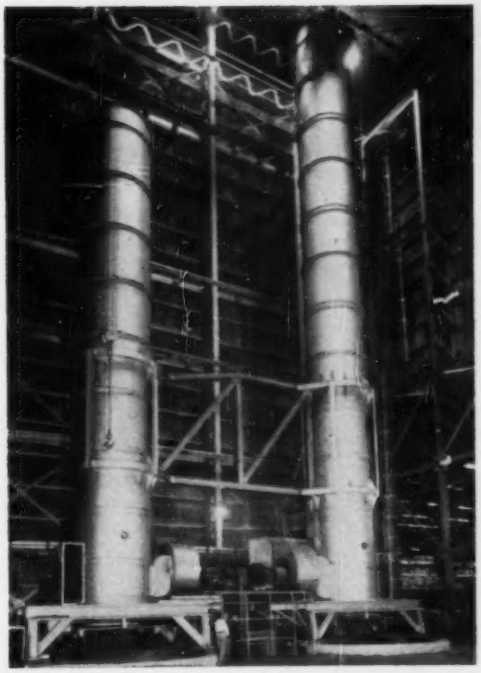
◀ Most powerful and versatile pulse testing modulator for testing high-power radar pulse transformers was recently placed in operation by Westinghouse. Test facility simulates input and load conditions to determine if the transformer can meet response requirements. Modulator can simulate loads from 1 to 50 megawatts peak, with pulse voltages up to 38.7 kv.

▲ Automatic welding gun, designed by Allis-Chalmers, is being used to weld tubes to the tube sheet of a 90,000-square-foot surface condenser during erection of the unit at the F. M. Tait Station of the Dayton Power & Light Co. The welding is performed with the heli-arc process. A tungsten electrode is used in an atmosphere of argon. The welding gun makes possible repeated high quality tube-to-sheet welds.

► RCA "teller-vision," TV transmission of signatures and account information from centralized bookkeeping departments to remote drive-in windows, is speeding depositor services at two Florida banks of the Sottile organization. Photo shows drive-in teller comparing check signature with depositor's record card on TV receiver at left.

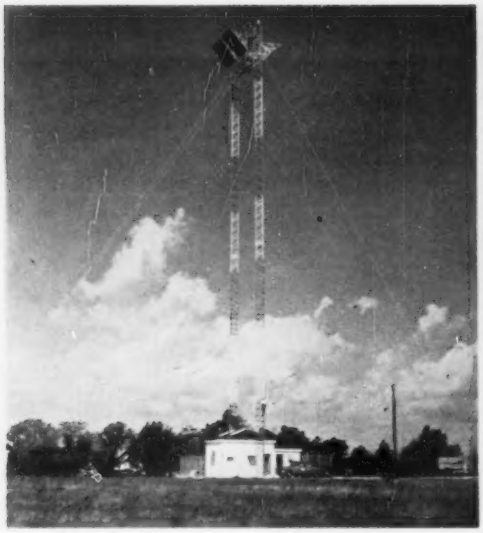


▲ An air calorimeter, designed and developed by General Electric, supplies in one integrated equipment a number of important testing functions. These include: an air supply that is accurately controlled in both quantity and temperature; several manometers; a timer; a barometer; and a hygrometer.



▲ Heat-treating furnace higher than a 10-story building is in operation at the Harvey Aluminum plant, Torrance, Calif. Vertical furnace was designed and constructed by Westinghouse to heat treat extruded aluminum alloy shapes. Aluminum pieces up to 80 feet long are heat treated at temperatures up through 800 F.

► New York City's third tube of the Lincoln Tunnel has a ventilation system powerful enough to change the air completely every minute and a half. A strategic combination of 11 blower and 13 exhaust fans built by Westinghouse maintain a constant flow of air, injecting it into the tube at roadbed level and exhausting it through openings above.



▲ In Western Union's newest chain of microwave relay stations, the passive reflector technique is used. These chains now handle 960 telegraph circuits in each direction.

The Martin Company

▲ The test unit seen provides an accurate means of inspecting wired plug assemblies. Unit will check for continuity short circuits and ground faults between the conductors and the shell of the conductor under test. The tool will also make a 500-volt high potential test to detect any faults not apparent with the normal low voltage test.

► This Phillips 1,000-channel analyzer, used as time-of-flight analyzer in measurements of neutron cross sections, sorts pulses according to their delay after a master timing pulse and stores them in 1,024 different channels.

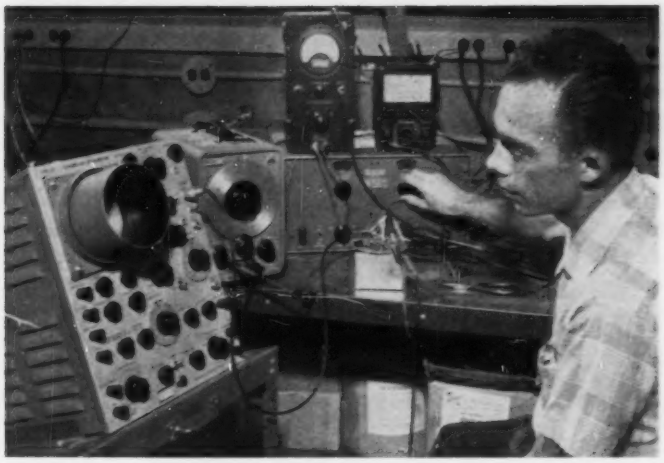
Courtesy Phillips Petroleum Co.

► Unique 4-wheel-drive truck can meet any emergency on the 5-mile long Mackinac Bridge. Truck has fire-fighting equipment, double boom derrick, and hydraulic aerial platform that rises 30 feet to replace bridge lights. Two-way radio keeps vehicle in touch with bridge patrol cars and administration center. Vehicle includes 100-ampere alternator.

▲ Lacrosse, the U. S. Army's surface-to-surface guided missile, is directed in flight by a highly accurate guidance system. The rocket-propelled, highly mobile artillery missile is designed as a field support weapon and is already in large-scale production. Guidance system was developed by Federal Telecommunication Laboratories, Nutley, N. J.

Official Photograph, U. S. Navy

▲ View of NRL's new 84-foot radio telescope located near Riverside in southern Maryland. Designed by D. S. Kennedy Company, it consists of an 84-foot dish-shaped antenna mounted at the top of a large steel supporting tower. The antenna, which is mostly aluminum, has a precise parabolic surface, permitting the study of radiations at 10-centimeter wavelengths.



▲ Miniaturized circuits developed by the General Electric light military electronic equipment department are helping to reduce the size of electronic equipments and systems for the military. An engineer in this photo is checking the characteristics of a small experimental circuit which may eventually find its way into a new piece of military equipment.

► Research in semiconductor materials has resulted in Peltier thermocouple materials capable of maintaining temperature differences of about 68 C. Shown in the hand of T. S. Shilliday, of Battelle's Solid-State Devices Division, is a miniature Peltier refrigerator. Thermocouple elements used were discs of p and n type bismuth telluride.

Courtesy Battelle Memorial Institute

▼ Levitation melting—heating metals thousands of degrees above white heat so that they float freely suspended in space—is used to prepare highly purified laboratory-scale ingots of niobium, zirconium, titanium, molybdenum, and many other alloys. Since the molten metal floats freely in space, no containing vessel is required; thus, traces of impurities that metals pick up in conventional methods are eliminated. The entire process is carried out inside a sealed vessel containing an inert gas such as argon to protect the pure metal from contamination by air.

▼ New technique for determining ferromagnetic core losses at high flux densities has been developed at the NBS. It is the result of analyzing the a-c bridge circuits commonly used for loss measurements and applying a correction term for the effect of the harmonic components of the exciting current.

Courtesy National Bureau of Standards

Courtesy Westinghouse Corp.

In order to obtain additional radiotelegraph channels in the overcrowded high-frequency spectrum, synchronized multiplex equipment has been developed which provides eight telegraph channels by means of time division "twinplex" frequency shift keying.

Radio frequencies also are being conserved by the operation of single-sideband systems which provide up to 12 telegraph channels on a single-radio-frequency carrier. This method is being employed by both American Cable and Radio Corp. and RCA Communications on their international radiotelegraph circuits.

An improved synchronous single sideband (SSSB) system has been developed by Motorola, Inc., which makes possible the utilization of this spectrum-saving technique to mobile radio and other communication services operating up to the uhf region. A reduced carrier is transmitted in addition to one sideband and an automatic phase control system at the receiver locks an oscillator to the reduced carrier signal for carrier reinsertion. Several advantages are claimed for this SSSB system which will make it a serious contender with FM for use in the mobile radio services and with AM for use in air and sea communications.

COMMUNICATION SWITCHING SYSTEMS

ALTHOUGH there were no outstanding engineering developments in the field of communication switching systems during 1957, there was a steady introduction of electronic methods and devices into the ever-expanding fully automatic local and toll dialing networks throughout the world. In addition, an increasing use of electronics is being made in telegraph switching systems, particularly in countries outside the Western Hemisphere.

At the present time, because of relatively simpler transmission and calling problems, the field of telegraph switching is receiving greater attention insofar as the introduction of fully or semielectronic means are concerned. Several new telegraph or data switching systems utilizing magnetic drum or core storage have been proposed or installed in several countries.

During 1957, the Bell Telephone Laboratories disclosed the details of a new electronic concentrator for reducing the number of trunks required to serve a large group of subscribers' lines. This unit, which can be installed in a building or on poles in a small but fast growing community or other residential area, acts to concentrate subscribers' calls to a small number of trunks to the central office. Calls from the central office to the subscribers served by such a unit are likewise concentrated at the central office end and then expanded at the unit at the subscribers' end.

COMMUNICATION THEORY

DURING THE PAST YEAR, further broadening of interest in communication theory has been evident. For example, an entire symposium was devoted to the application of communication theory to antenna design and optics. Fundamental work on the learning and thinking process is increasing both in America and abroad. It is encouraging news that several prominent mathematicians have reported research on communication theory. As evidence of increased interest throughout the world, authors from at least five foreign nations—England, France, The Netherlands, Japan, and the Soviet Union—have published papers on communication theory in American journals. A new journal, *Information and Control*, which will publish papers on the theories of communication, computers, and automatic control, began publication this year.

Advances in coding theory have been reported. An upper bound has been obtained on the probability of error for the optimal code in the memoryless finite discrete channel, and an equation has been developed for the capacity of a finite statute channel when the state can be calculated on both transmitting and receiving ends. A sequential coding scheme which differs from block coding has been devised for reliable communications. There was considerable activity in the general area of extracting signals from noisy backgrounds, including the estimation in the presence of noise of the impulse response of a random linear filter, the output signal-to-noise ratio of correlation detectors, and a systematic approach to a class of problems in the theory of noise and other phenomena. There has been a study of the relationship of sequential filter theory to information theory and its application to the detection of signals in noise. In addition, results of research on the optimum detection of signals in multipath or scattered communication were reported. Further progress has been made in understanding and devising binary coding systems, and a paper has been published on the information theory of decision feedback. Significant new studies have been reported on the rate at which a human can perceive and use information.

Among the systems designed which involve extensive use of communication theory are the ORDIR radar system developed at Columbia University and the Collins Kineplex data transmission system.

TELEVISION AND AURAL BROADCASTING SYSTEMS

DOZENS of 10-watt uhf translator stations went on the air during 1957, bringing television service from distant stations to many communities where television signals had not previously reached. More than 100 translator applications have been granted by the Federal Communications Commission (FCC) and more applications are pending, indicating the success and acceptance of these inexpensive units for extending television service. These supplement the more than 500 regular television broadcast stations now operating in the United States, and few populated areas remain without at least one television service.

The Television Allocations Study Organization (TASO), which began regular operation at the beginning of 1957, was very active in studying the technical status and problems of uhf and vhf television for the FCC. About 175 engineers, representing 88 organizations, are participating in the six panels and associated committees of TASO. It is expected that the studies and

final report of TASO will be completed during the latter half of 1958.

Video tape recording, using 2-inch magnetic tape moving 15 inches per second, was used with good results by the networks at their western studios for delayed black-and-white television programming. Refinements in the equipment were made by the manufacturer, and regular production appeared near. Color video tape recording was demonstrated late in the year by another manufacturer, using equipment and standards that are compatible with present black-and-white video tape techniques.

A wired pay television system was installed in Bartlesville, Okla., and the FCC announced procedures for filing applications early in 1958 for experimentation in pay television broadcasting. Three principal systems for scrambling and unscrambling television pictures are being urged by their proponents, and several other systems have recently been suggested.

Wide acceptance was given to the newly developed 110-degree deflection picture tubes, permitting television cabinets to be much reduced in depth.

General Electric 8,500-hp gas turbine–electric locomotive for the Union Pacific Railroad. Lead unit contains cab and auxiliary equipment; gas turbine in trailing unit and tender holds 24,000 gallons of fuel.

General Applications

LAND TRANSPORTATION

The New Haven Railroad has three newly designed lightweight diesel trains which can, with engines shut down, continue into Grand Central Terminal, New York City, on 600-volt d-c third-rail power. The Fairbanks-Morse locomotives coupled to American Car & Foundry Talgo cars and the Baldwin-Lima-Hamilton locomotives coupled to Pullman Standard's Train X cars have electric and mechanical propulsion, respectively. On both trains, locomotive alternators furnish the cars' heat, light, and air-conditioning. The Budd Company train has two diesel engines for mechanical propulsion on each car. The engine cooling system furnishes car heat while light and air-conditioning depends on engine-driven 64-volt d-c generators. All three types of equipment, through various adaptations of d-c motors, will utilize third-rail power through the underground approach to Grand Central Terminal.

A portion of the video tape recording and playback installation at the Columbia Broadcasting System's Television City, Hollywood, Calif.

The New Haven Railroad is receiving delivery on 60 Electro-Motive locomotives. These are new streamlined diesel-electric locomotives equipped to run on 600-volt d-c third rail into Grand Central Terminal or Pennsylvania Station, New York City. They have 1,750-hp diesel engines and, because of added weight of third-rail equipment, have four- and six-wheel trucks.

The success of the 4,500-hp turbine–electric locomotives has caused Union Pacific Railroad to order a similar 8,500-hp version from General Electric (GE). Believed to be the most powerful internally powered locomotive, these units are designed for high-speed freight over the western mountains. The 30 now on order are made up of a lead unit containing cab and auxiliary equipment, gas turbine in the trailing unit, and 24,000-gallon fuel tender, in all 179 feet long with 816,000 pounds on drivers.

Two 125-ton 2,400-volt d-c electric locomotives delivered for the haulage of copper ore have a 46% better power-to-weight ratio than those in service since 1913.

After careful analysis, General Electric designed a world-wide diesel–electric locomotive, basically standard but having flexible features to fit many applications in the 900- to 1,800-hp range. Although designed this year, substantial foreign orders are already on the books.

New commuter multiple-unit cars have been ordered from Budd Company by the Pennsylvania Railroad. These are equipped with transformers and rectifiers to change 11-kv 25-cycle power from an overhead system to 650-volt d-c for traction motors through right-angle hypoid gear drive to the axles.

Boston Metropolitan Transit has received 50 lightweight rapid transit cars from Pullman Standard. The

four GE 100-hp 300-volt d-c traction motors used on these cars are 43% lighter than a former comparable design. The external accelerator resistors are also used for motor load in dynamic braking.

PRODUCTION AND APPLICATION OF LIGHT

MANY ADVANCEMENTS have been made during 1957 in light sources, lighting equipment, and application techniques. For example, activity in electroluminescent panels has been greatly intensified during 1957; in one year's time it has progressed from a basic research stage to pilot production and initial order stage. The first commercial application now planned will be in the slide-rule dial on the station selector of a new Westinghouse radio set.

New fluorescent lamps (type *SHO* by Westinghouse, *VHO* by Sylvania, and *PG* by General Electric) produce 2½ times as much light as the previous standard rapid-start lamp. The development was made possible by use of a mixture of rare gases that permit extremely high energy loading of the electrodes, arc stream, and the phosphor. The proper vapor pressure necessary to high operating efficiency, and which would normally be exceeded as the wattage of the lamp is increased, is obtained by the use of cooling chambers located in each lamp.

Previously used primarily for street and industrial lighting, where light efficiency is more important than color, mercury-vapor lighting is now equipped for use in stores, offices, schools, auditoriums, or practically any other type of commercial application. By applying a combination of additive and subtractive color correction, the excessive yellow–green color has been subdued in favor of the more flattering warm colors. The new Deluxe white lamps, as they are presently designated, are available in ratings ranging from 400 to 1,000 watts. One outstanding installation of these new lamps is in the offices of the Georgia Power Company at Atlanta, Ga.

Since the advent of fluorescent street lighting in this country several years ago, fluorescent street luminaires have been mounted perpendicular to the curbline. Such an arrangement did not direct light adequately onto the roadway area. The coefficient of utilization, which is a measure of the percentage of light emitted by the lamp was approximately one third that of the highly developed optical system used with the incandescent and mercury lamps. A new fluorescent type *HUS-72* luminaire announced by Westinghouse improves the coefficient of utilization from a fluorescent unit, making it comparable to the incandescent and mercury luminaires. This is accomplished by mounting the lamps parallel to the curb, and employing a prismatic plastic refractor to provide additional light control. The new luminaire will produce a maximum of approximately 20,000 lumens.

Development of the first transistorized, packaged sources of high-frequency power has been reported by engineers at Westinghouse Electric Corporation, Lighting Division. As it is incorporated in standard equipment in coming months, it is expected to eliminate technical and economic obstacles now inhibiting broad application of high-frequency lighting. Prototypes already functioning in a lighting system for Westinghouse offices supply power at 1,500 cycles to 64 standard 40-watt rapid-start fluorescent lamps. These new power packages are only a fraction of the weight and size of conventional frequency converters now in use. Of major importance is the high reliability afforded by semiconductor devices, as well as the fact that frequency-converter units can be installed very near to the lighting load without long high-frequency runs. Among the advantages are their suitability for small- or large-scale installation wherever desired, in either a new or old structure; their high reliability and negligible maintenance requirements; their silent and vibrationless operation; and their ability to operate at more than 90% efficiency over their entire load range.

Courtesy General Electric Company

Programming and readout system for Allegheny Ludlum Steel Corporation plant at Brackenridge, Pa.

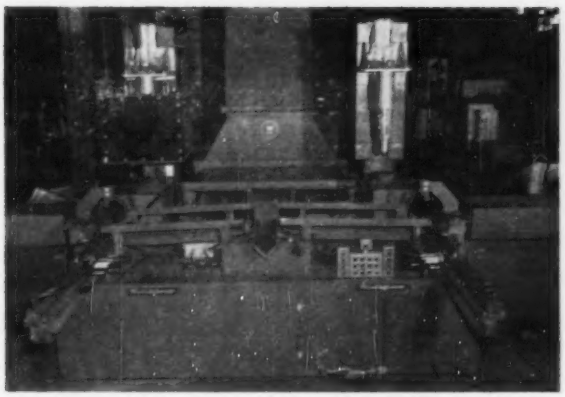
Industry

FEEDBACK CONTROL SYSTEMS

EMPHASIS in feedback control systems activities this year has been in the direction of more comprehensive controls in which the instrumentation, computing data logging, and control components are blended together into systems capable of performing increasing amounts of human skill and judgment, as well as the more familiar power control functions. In addition, advances in missile and aircraft guidance have been made as a result of improved gyro and inertial guidance components as well as feedback control systems.

Steel Mill Data Logger. A digital programming and data logging system for a four-stand tandem cold steel strip mill has recently been delivered to the Allegheny Ludlum Steel Company. It is believed that this is the first equipment of its kind to be applied to a large rolling mill.

This mill is also being equipped with automatic gauge control. The programming functions involve pre-



Courtesy Westinghouse Electric Corporation

Assembly incorporating two "magic cube" automatic positioners will anneal the nose and body of 150 eight-inch shells per hour.

setting the two X-ray gauges and gauge controls from a punched card associated with each coil. The punched card also includes coil identification data which is typed with the readout data for each coil. The readout includes date and time from a digital clock, operator and shift number inserted by switches, data on length of strip within and outside of thickness tolerance, and, finally, total length and weight of coil. If the mill is required to be shut down for any reason, the delay time and reason are recorded and printed out. The typewritten readout is used directly as a production report. In addition, a punched tape is produced, from which punched cards are made and used to prepare the payroll automatically.

As the steel industry becomes more automated, it is expected that many similar and more complex systems will be installed.

Numerical Control of Machine Tools. Working closely with Aircraft Industries Association, machine tool control manufacturers have worked out integrated systems of machine tool controls that have been installed during the current year in a number of airplane manufacturing plants. The results from these installations have been most favorable, with greatly decreased machining time realized and uniformly high quality parts produced.

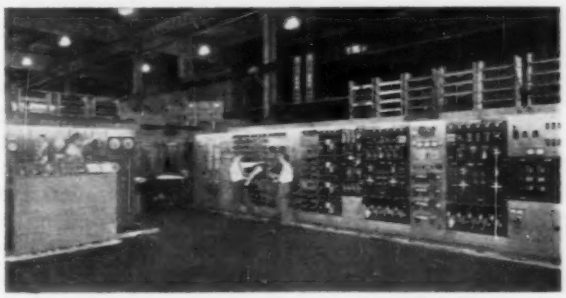
Inertial Guidance. Details of inertial guidance systems which provide a jamproof form of navigation for airplanes, missiles, and ships were disclosed by the Massachusetts Institute of Technology during the past year. Developed in the main by Dr. C. S. Draper and Dr. Walter Wrigley, these systems combine precision gyroscopes and a Schuler-tuned pendulum, as well as computing and control devices, into an integrated means for piloting any suitable craft to any spot on earth or in space. More advanced inertial guidance systems are being developed which are still under military security restrictions.

Computers in Control. Increasing activity has taken place during the past year in the combining of computers and control systems. A special technical conference, sponsored by AIEE Feedback Control Systems Committee, was devoted to this subject. The papers and discussions stressed the fact that the area of optimizing controls, in which the process being controlled is only partially understood, presents a challenge to the control systems designer. For those systems where the process is well understood, such as in the machine tool and inertial guidance examples noted previously, the operation of computers and control has been highly successful.

ELECTRIC HEATING

ALTHOUGH there were few outstanding developments in electric heating during the past year, there was a substantial spread of use in almost every division of the field. New uses were found for the various kinds of resistance and radiant heaters. Large vacuum melting furnaces of both the arc and induction type were put into commercial operation for melting high-temperature and specialty alloys. Low-frequency induction heating was expanded for heating still larger billets for hot forming and extrusion, and other low-frequency furnaces drew attention for melting operations.

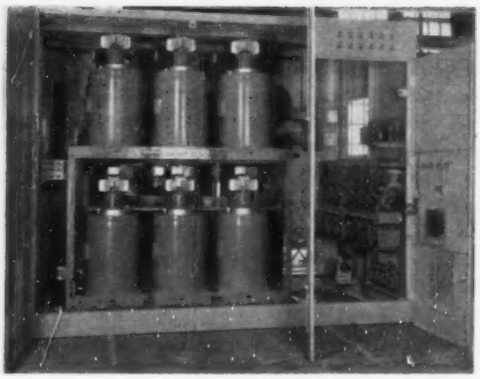
Most groups were busy combining electric heat and automatic or semiautomatic handling devices to meet industry's insatiable demand for mechanization.



Courtesy Cutler-Hammer, Inc.

This automatic charging control system has been installed on a new blast furnace. The control was designed to meet high production rates and to provide greater flexibility in the charging program than was heretofore available.

A rather ingenious positioning device was introduced by Westinghouse in one of its all-60-cycle induction heating assemblies designed for heating 8-inch shells for a combined lip and body annealing operation. A feature of the assembly is what Westinghouse calls its "magic cube"—a device which receives a shell body from a horizontal in-feed conveyor, rotates it to a vertical position for the heating operation, then returns it to a horizontal out-feed conveyor at right angles to the in-feed line. By simple rotation of 120 degrees for each station, the magic cube loads, up-ends, and unloads shells at the rate of 75 per hour in completely automatic sequence. Since each assembly contains two stations, the output is 150 of these 8-inch shells per hour per machine.



Courtesy Westinghouse Electric Corporation

High-capacity sealed ignitron rectifier, metal-enclosed design.

INDUSTRIAL CONTROL

THE ELECTRICAL CONTROL INDUSTRY is constantly meeting the problems of automation. These problems are being solved by the ever-present contactor and relay, with the aid of electronic controls, magnetic amplifiers, and static switching systems.

New automatic-programming blast furnace charging controls have been developed, providing greater flexibility in control of charging mix with a wider range of base materials.

Ignitrons have been used in a new approach to a constant-current adjustable-speed motor drive, and to control equipment for missile thermal-barrier tests.

Magnetic amplifiers and static switching systems have been applied to automotive press control, as well as to synchronized conveyor lines. Saturable reactors are being used to control atomic pile control-rod motors.

In addition to the production of new controllers and control systems, there has been considerable activity in components parts improvement. D-c contactors have been developed in unit construction providing front connection. This type of device is particularly adaptable to crane control.

INDUSTRIAL POWER RECTIFIERS

APPROXIMATELY 200,000 kw of high-capacity sealed ignitrons have been manufactured during 1957 for electrochemical applications at 850-volts d-c. All of these were of the metal enclosed design.

It is of interest to note that there is an increasing trend toward the use of ignitron rectifiers for main drive applications in the steel mill industry. This is evidenced by the fact that approximately 80,000 kw of main drive ignitron equipments were placed on order during the current year. Factors such as reliability, high inherent speed of response, low maintenance cost, low installed cost of equipment, and high efficiency are believed to be responsible for this trend.

MINING AND METAL INDUSTRY

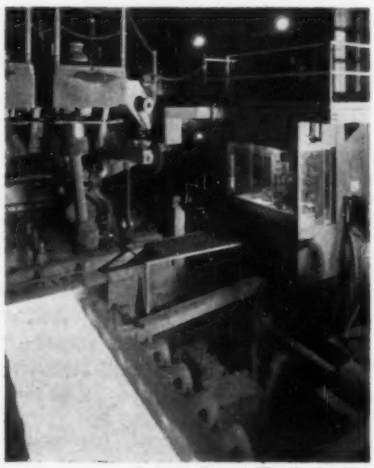
Metal Industry. As the steel industry accelerates its evolution from mechanization to automation, there is an increasing trend to larger machinery, higher processing speeds, and greater production capabilities. Keeping pace with this trend, the electrical industry is constantly developing the new and improved electrical techniques, systems, and equipment required.

Greater process flexibility is provided by card program control. Using standard punched cards compatible with accounting, data logging, and processing systems, an operator can maintain a large number of optimum schedules for a wide variety of products. Several such equipments were installed for the first time in the steel industry during 1957. For example, on the first such system installed at the Allegheny Ludlum Steel Corporation, Brackenridge, Pa., a 15-pass schedule and product data is programmed on one card. The operator selects the desired card, inserts it in "card reader," and pushes the "next pass" button to start each pass. The card control system automatically sets the screw position and mill speed for the pass.

Westinghouse programmed digital automatic control (PRODAC) permits the full automatic control of primary reversing mills in the rolling of steel and aluminum. This equipment, making extensive use of transistor circuitry, permits the operator to press a push button and initiate complete automatic rolling of a slab or bloom. Information input to the control is accomplished by use of punched cards on which data relating mill speed, horizontal and edger rolls separations, etc., for each pass are represented in digital form.

Lukens Steel Company's new 140-inch reversing plate mill now being built for the Coatesville, Pa., plant will be the first large reversing mill in the Western Hemisphere to have a rectifier power supply. Ignitron pumpless rectifiers will supply direct current for the mill's 10,000-hp twin-motor main drive and a 3,000-hp edger motor. "Back-to-back" operation of the rectifiers will give reversing and pump-back functions to the motor.

The Westinghouse CYPAK or static elements used for switching purposes are being used now for the automation of blast-furnace charging and skip-hoist operation. These units are replacing conventional relays.



Overhead view of entrance end of reversing rougher, Allegheny Ludlum Steel Corporation.

Courtesy General Electric Company

Courtesy Universal Atomics Corp.

Advanced precision transistorized ratemeter for radiation measurement and monitoring.

switches, and telephone type relays to perform the programming and charging of the furnace. The over-all control will charge the furnace according to a preselected program and will automatically sense and control the many sequences of operations of the charging devices associated with the blast furnace. Because of the static nature of this equipment, the maintenance requirements will be materially reduced and more reliable operation than previously obtained will be realized.

Mining. Because of greater dependability, reduced maintenance, and more economical operation available from a-c equipment, the eastern United States coal mining industry is expressing a great interest in changing from d-c to a-c face equipment. To meet this trend, two types of a-c shuttle cars have been offered to the industry. One design uses a single motor to power the various functions through clutches and transmissions and the other design uses from three to five separate motors. Actual field experience has proved that alternating current is practical for powering shuttle cars and offers the usual advantage of reduced maintenance.

Several manufacturers have received United States Bureau of Mines approval for use in coal mines of full-face lighting units based on fluorescent tubes and fixtures which were designed to provide the required safety features dictated by the proximity of explosive mixtures of methane and air.

Instrumentation

AIRCRAFT AND FLIGHT TEST INSTRUMENTATION

ONE OF THE PRIME CONSIDERATIONS in determining flight test instrumentation design criteria is that of over-all equipment component size, the idea in mind being to achieve maximum space utilization without sacrificing equipment operational reliability. Recent developments in the field of transistorized airborne data acquisition systems and miniaturized instrumentation converter systems have reduced greatly the amount of space required for such equipment in aircraft and missiles in relation to the over-all space which may be required for the guidance and propulsion systems, fuel supply, armament, etc.

Some of the features provided for in a transistorized airborne data acquisition system designed by the Electronic Engineering Corporation of California include: magnetic tape recording of all flight data; silicon transistor circuitry, with the exception of a vhf radio timing receiver; system operation over a temperature range of —55 C to 100 C; capability of handling data by standard FM subcarrier oscillator techniques; capability of handling data by direct recording; recording of timing signals along with data to provide correlation; compatibility of all recording with a central data-processing system; incorporation of a tape speed compensation; in-flight calibration of all subcarrier oscillators; and operation of all equipment from standard 400-cps aircraft power.

A very important portion of the program had to do with design of a strain gauge oscillator and a voltage-controlled oscillator for the FM package. Both of these oscillators are plug-in type assemblies contained in a housing 3¼ inches by 1⅛ inches by 1⅞ inches.

All of the aforementioned equipment has been manufactured and has operated in the laboratory under conditions of varying voltages and temperatures, and operation under vibration. Progress to date indicates that the system is completely feasible.

In designing miniaturized instrumentation converter systems, development of the printed circuit has made possible a new approach to the problem of adapting transducer output signals to fit recorder input requirements. This has resulted in the development of a converter box having a volume of less than 100 cubic inches. Such a box has provisions for plugging in seven printed-circuit cards which carry the necessary components and circuitry required to amplify, attenuate, rectify, or shift signals as may be necessary. The base of the box is itself a printed circuit bus bar providing operating voltages for the plug-in cards.

This type box will replace conventional bridge balance boxes and telemeter adapter boxes. The combination of subminiature components and printed circuitry affords a substantial reduction in space requirements and consequently reduces installation problems. The plug-in feature permits rapid changing of converter cards when test programs are changed, and new cards can be designed and built as new instrumentation needs arise.

General Electric watt-hour meter employs single driving element to reduce network metering costs.

NUCLEONIC AND RADIATION INSTRUMENTS

SIGNIFICANT DEVELOPMENTS in instrumentation associated with nuclear work has progressed in both reactor instrumentation and in monitoring.

Reactor control-rod drive mechanisms using canned electric motor drives, commercial gear motors with rotary seals, and linear seal drives have been used; but a somewhat different approach with a magnetic jack type electromagnetic drive utilizing a step motion was revealed recently by Argonne National Laboratory. It is claimed to be reliable, fail safe, rugged, long-lived, dirtproof, maintenance-free, sealless, and inexpensive.

Instrumentation has met the performance requirements not only of boiling and pressurized water and sodium-cooled reactors, but also of organic moderated and gas-cooled reactors, as well as other types under development. Educational institutions are emphasizing courses of instruction on reactor control, in many cases with actual reactors or electrical simulators for training purposes.

In addition, 1957 saw a trend simplifying nuclear control equipment by combining the reactor controls with plant controls. This simplification sometimes involved mimic, graphic, or panoramic layouts of the reactor and plant instrumentation. The use of television monitoring equipment and simplified presentation of indications has increased. Another important trend has been an increasing effort in some instances to provide highly specialized components to meet exacting requirements of reactor environment. An example is a thermocouple with time constants of less than 2 milliseconds available now on a routine basis.

Instrument transistorization has progressed. Typical in this field are a survey meter of extreme sensitivity meeting U.S. Navy requirements, a completely portable ratemeter, and a multichannel scaler analyzer. In the case of the latter, it was claimed that a 1-ton instrument was reduced to a weight of 100 pounds through the use of transistors and printed circuitry, etc.

Miscellaneous items include a thousand channel analyzer which has just been placed in use with the Materials Testing Reactor's fast neutron chopper as a time-of-flight analyzer, a panoramic camera for corrosion inspection of plate-type fuel elements, and a nuclear light source felt to be the brightest long-lived source yet developed. Other developments include a nuclear battery, relatively independent of temperature changes, for providing continuous low-voltage power.

RECORDING AND CONTROLLING INSTRUMENTS

THE TREND OF ADVANCES this year has been in the direction of systems and the application of equipment to their control. Instruments and techniques, often well-developed individually, have been combined and offered for over-all control and optimizing of industrial processes from steel and glass making, to petroleum and chemical products manufacture. Some specific developments have been:

Large-Scale Data Loggers. Equipment is offered by several companies for sampling large numbers of process variables, in some cases providing on-line computations for linearization and scale factor, and presenting these variables as a typed output sometimes with auxiliary tape output.

Magnetic Data Recording. Long used in aircraft and computer fields, magnetic recording is now being utilized in commercial processes and research for automatic data correlation.

Direct Recording Oscillographs. Several versions have been offered of galvanometer-type oscillographs giving an immediate record without wet or vapor chemistry. Special light sources and papers constitute one approach, xerographic methods another.

New Inking Systems. Novel inking systems have been developed for several recorders involving new viscous inks and flexible plastic ink reservoirs.

Digital Process Controller. A number of digital aircraft-type computers have been adapted for process control. At least one is offered as particularly designed for the purpose. This type of equipment permits optimizing and self-adaptive control modes.

Optimizing Controller. One special controller has been offered which controls to a slope rather than set-point, thus permitting the solution of some optimizing problems.

Small-Case Electric Recorders. Practically every industrial instrument company and some new ones in the field are offering small-case recorders in the trend toward smaller control rooms and consoles.

TELEMETERING

THE REMARKABLE INCREASE in the interest shown by manufacturers, users, and the general public in telemetering during 1957 is attributable to three principal causes, viz.:

1. The development of military *operational* requirements for telemetering systems, as opposed to the previous belief that operational telemetering was unacceptable.

2. The controversy over long-range missiles, and the launching of two earth satellites, as a part of the IGY program, itself dependent on many forms of telemetering applications.

3. The increasing exploitation of methods of automation in industrial processes, and the realization that the vast amounts of data required can be obtained in a reasonable time only by using telemetering.

During 1957, improved applications of digital type code were achieved for power control and telemetering by utility companies. One such equipment provides direct logging of data on typewritten sheets, readout of the last data received before a power failure, and a fail-safe system combination for telemetering and control as applied to industrial problems.

A modulation was devised which transmits intelli-

gence as a series of high-frequency bursts. Data is contained within these complex signals by three characteristics. These are (1) the time duration of a burst, (2) the time interval between two bursts, and (3) the frequency of the bursts. This modulation system is to be used in Project Vanguard.

Much work has been done in designing radio telemetering packaging with a very high space utilization ratio. In the U.S. satellites, this technique has been employed in conjunction with the use of very low powered transmitters, of the order of 1 to 5 milliwatts, and the reception of their weak signals at great distances by the Minitrack receiving antenna arrays and special radio receivers.

Telemetering pickups have been built to operate at 500 F, while exhibiting useful accuracy and sensitivity to acceleration at a frequency of 20,000 cps. The use of vibrating wires as pickup devices has been improved and stabilized. New types of gyroscopic pickups have been made which still further reduce the effects of friction and precession occurring in earlier types.

Increased use of semiconductor devices, magnetic cores, and similar alternatives for vacuum tubes, has been noted in telemetering equipments and installations. These elements have been accompanied by microminiature components and improved potting techniques.

Phase-locked loops have been used in an FM telemetering radio receiver as discriminators or tracking filters. This technique has resulted in an appreciable increase in the limiting point or threshold, and in a substantial reduction in the over-all system error.

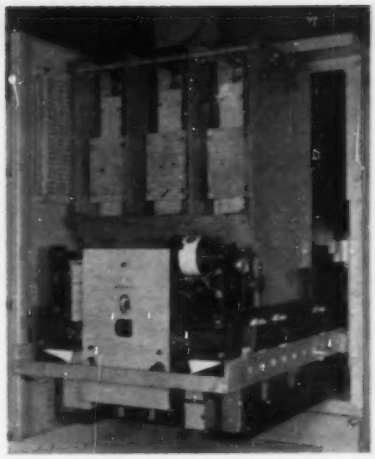
Studies in the theory and practice of FM multiplex reception have confirmed that the amount of data that can be transmitted accurately by a given telemetering system is strictly limited. The content capability of a system is not affected by the form of the data, which may be of the amplitude, frequency, or phase type, each type singly or in combination with one or both of the others. In this connection, adjacent channel interference is of equal importance with the bandwidth.

New types of data plotters and display units have been developed. One type of plotter can accept either analog or digital input signals, select any one or more of 13 different symbols, and plot at a rate of 70 (average) displays per minute with very great accuracy over an area of 1,600 square inches.

Power

RELAYS

IMPORTANT DEVELOPMENTS announced during 1957 were concerned primarily with distance relaying. A new approach to the problem of distance relaying of transmission lines for interphase faults was announced. This new approach is on a polyphase basis rather than a single-phase basis, and uses two well-known and established principles. The first of these is concerned with the action of line-drop compensators in reproducing, in miniature, a voltage corresponding to the voltage drop existing on the transmission line to the so-called balance point for faults at that point or beyond. The second principle is concerned with the fact that a polyphase motor will develop torque in one direction with a given order of phase rotation and will develop torque in the other direction with the reversed order of phase rotation. Utilizing these two well-known principles, a distance relaying scheme was devised making use of static networks wherein the number of active electromechanical units for a 3-phase line terminal of relaying was significantly reduced.



This high-voltage breaker, for combat vessel applications, was developed by Westinghouse under a U. S. Navy contract. It has a continuous rating of 2,000 amperes at 2,300 volts a-c, with an interrupting rating of 55,000 amperes at rated voltage.

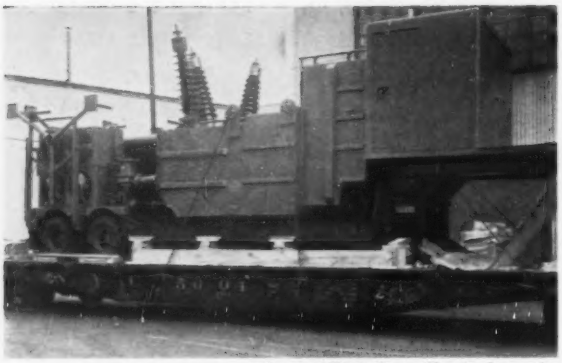
A new directional-comparison carrier-relaying terminal now offers separate carrier and relay back-up circuits. It also provides back-up protection for both the relays and the breaker. Such a step is deemed necessary, since the customary backup at the next station is becoming inadequate on the modern power system, and will probably become increasingly inadequate in the near future. A new relay composed of an offset mho carrier-starting unit and an improved mho carrier-stopping unit has been designed to form the basis for the new carrier-relaying terminal.

A new 2-step directional–distance overcurrent relay has been designed specifically for the protection of subtransmission lines. This relay introduces the new concept of having a nondirectional time–overcurrent unit control a directional–distance mho unit. This provides a class of protection intermediate between directional–overcurrent relaying and stepped-time distance relaying for applications where directional relaying is inadequate and stepped-time distance relaying is not economically justifiable. This form of relaying is actually superior to stepped-time distance relaying for co-ordination with fuses and inverse time–overcurrent relays.

POWER GENERATION

PROGRESS continues to be made in station economies from the standpoint of larger steam generating units. Sizes of units now being planned extend to 500 mw and several units in the 300- and 400-mw class are in various stages of construction.

Increased attention is being given to steam pressure



Courtesy Westinghouse Electric Corporation

The 15,000-kva mobile substation is one of the first having a series–multiple arrangement for a high voltage of 138 kv. The unit, designed to be moved completely filled with oil, weighs 92,500 pounds.

in the supercritical range, and throttle pressures up to 5,000 psi are being planned. An outstanding development during the year was the placing in service of the first supercritical pressure double reheat generating unit, which is installed at the Philo Station of the Ohio Power Company on the American Gas and Electric Company System. Steam conditions for this 125,000-kw unit are 4,500 psig, 1,150 F/1,050 F/1,000 F. The successful operation of this first unit, using new concepts in boiler and turbine designs, will provide the necessary experience for design of the much larger supercritical pressure units now on order.

The use of larger-size units and higher steam pressures has made the use of turbine-driven boiler feed pumps more attractive. During the year, the first modern generating units using turbine-driven boiler feed pumps went into service. An alternate method adopted by a few utility companies drives the boiler feed pump directly from the main turbine–generator shaft. Most utilities, however, have continued to use motor drives on all auxiliaries, and the present availability of higher rated switchgear for the auxiliary power systems has made it economically feasible to continue this practice in many cases.

Nuclear power plant costs are being subjected to searching analysis because of higher costs than were shown on original estimates. At this time, it appears, from these higher costs, that the time when this source of energy will become competitive with conventional fuels will be delayed substantially longer than was believed to be the case earlier.

INSULATED CONDUCTORS

THE 3-YEAR RESEARCH PROJECT being carried on at Princeton University on the thermal resistivity of soils is nearing completion. Several technical papers covering various phases of the work are now in preparation and will be published in the near future.

Not only has a better understanding of the phenomena of the thermal conductivity in various types of soils been obtained through this project, but equipment for making accurate and rapid measurement of significant soil properties has been developed. Especially noteworthy are the reliable nuclear instruments for the determination of soil density and moisture content *in situ* that are now commercially available.

This study will be of value in connection with a publication giving ampacity (current-carrying capacity) of insulated cables under various conditions of installation and operation. These ampacity tables are now in preparation as a joint undertaking between the AIEE Insulated Conductors Committee and the Insulated Power Cable Engineers Association (IPCEA). When complete, they will constitute a revision and extension of a similar publication prepared by the IPCEA in 1943.

Cable sheaths and coverings have received considerable attention. In late 1956, a University of Illinois bulletin, "Creep, Fracture, and Bending of Lead and Lead Alloy Cable Sheathing," was published. This was the final report on a 27-year investigation of lead and lead alloy cable sheathing.

Increased use of coverings over lead and publication in January 1957 by the Association of Edison Illuminating Companies (AEIC) of "Specifications for Neoprene Protective Coverings for Impregnated-Paper-Insulated, Lead-Covered Cable" has resulted in the accumulation of considerable data on this type of covering.

Sheaths of materials other than lead are receiving increasing attention; and reports on the manufacture and use of aluminum and steel sheaths, both plain and corrugated (for increased flexibility), are appearing in technical literature.

The extensive research project for the field testing of extra high-voltage cable, jointly sponsored by the AEIC and the Edison Electric Institute (EEI), has resulted in several aggressive research efforts and in the development of high-capability cable systems for operation at 345 kv by co-operating cable and accessory manufacturers comprising Anaconda Wire and Cable Company, General Cable Corporation, The Okonite Company, Phelps Dodge Copper Products Corporation, G & W Electric Specialty Company, and Ohio Brass Company. Initial progress reports on this project have been made, according to which field testing is scheduled to begin in 1959 on the basis of anticipated response to the solicitation for the required financial support by individual electric utilities.

The "Underground Systems Reference Book," sponsored by the EEI, which is a revision of the publication of the same name by the National Electric Light Association in 1931, was published in August 1957. This book, edited by over 100 specialists in all phases of the industry, assembles under one cover the latest and most authentic information on underground electric transmission and distribution systems.

SWITCHGEAR

A NUMBER of important oilless circuit breaker developments were made in 1957.

Several new ratings of metal-clad switchgear with

air-magnetic type power circuit breakers have been announced. The 13.8-kv equipment has been extended from its former maximum breaker interrupting rating of 750 mva to 1,000 mva with 1,200- and 3,000-ampere continuous current ratings. Also, the 4.16-kv equipment now includes a 350-mva 3,000-ampere breaker rating. Manufacturers have announced that this breaker will close and latch against 80,000 amperes. This new development should help prevent power plant bottlenecks. It has been increasingly difficult to handle some of the auxiliary power systems for new big generators with the previous maximum rating of 250 mva.

Interest continues to grow in outdoor air-blast circuit breakers for high-voltage service. Several types of 138-kv 10-million-kva air-blast circuit breakers were introduced during the year.

New uses of sulfur hexafluoride for arc suppression are now developing. Trial installations of SF_6 low-capacity 46-kv and 115-kv circuit breakers have been made. Important capacitor switching experience with both SF_6 and vacuum switch devices has been recorded.

Despite this interest in oilless circuit breakers, the principal production for outdoor types continues in the oil circuit breaker designs. A large number of 230-kv oil circuit breakers of the new 15-million-kva rating have been ordered. Use of the 345-kv oil circuit breakers has been extended. New 345-kv designs include both 25-million-kva interrupting capacity rating and 1,300-kv impulse insulation level.

The year 1957 witnessed the development and production of automatic circuit reclosers with increased current-carrying capacity and interrupting ability. Reclosers with load current ratings up to 560 amperes and symmetrical rms current interrupting ratings up to 12,000 amperes at 4.8 kv, 10,000 amperes at 8.32 kv, and 8,000 amperes at 14.4 kv are available at present.

SUBSTATIONS

DURING THE PAST YEAR, important applications were made of the recently developed stored-energy operating mechanism for air–magnetic type power circuit breakers used in metal-clad switchgear. In a large urban substation of some forty 12-kv 750-mva metal-clad switchgear units on a public utility system, these mechanisms permit the simultaneous closure of all of the feeder circuit breakers for complete energization of the a-c network under emergency conditions after an outage with minimum control power requirements. The ampere capacity of the operating battery is less than 5% of that which would have been required with conventional solenoid-operated circuit-breaker mechanisms for this particular application.

TRANSMISSION AND DISTRIBUTION

UNEXPECTEDLY HIGH lightning flashover rates on towers of new extrahigh-voltage (EHV) transmission lines have been the subject of intensive studies during 1957. Results indicate that the magnitude of the surge impedance of the tower itself must be considered in calculating lightning performance. Other observations, coupled with the inability to account for the high outage rate of EHV lines and lines employing extrahigh towers by accepted methods, suggest a need to expand the methods. This would include consideration of steeper lightning stroke wave fronts, shorter waves, surge impedance and inductance of the tower, and revising the method for representing the stroke.

The nuclear reactor in building at right is part of the Sodium Reactor Experiment (SRE) being conducted by Atomics International, a Division of North American Aviation, Inc., for the U. S. Atomic Energy Commission. Electricity is generated by an experimental power station installed adjacent to the reactor by the Southern California Edison Company. The project is located in the Santa Susana Mountains, near Los Angeles, Calif.

Several experimental installations of a new device, the Cougnard deionizer, for lightning protection of transmission lines have furnished interesting results during the short time they have been in service in the United States. Further investigation is merited.

The problems of transmission and distribution lines in areas of high industrial contamination are receiving attention in the form of recent developments in the use of silicone and other compounds for treating insulators. Aluminum coating of the steel core wire of ACSR (aluminum cable, steel reinforced) indicates improved resistance of this type of conductor to atmospheric corrosion. Corrosion of steel tower footings and anchor rods has also attracted considerable interest.

The advent of the completely air-conditioned integrated "shopping center" under one ownership versus the old individually owned main street business frontage of a few years ago has raised new problems in power distribution. Continuity requirements of these loads, ranging up to 12,000 kw, justify the use of multiple-circuit supply to spot networks which, in most cases, utilize completely underground equipment.

There are interesting developments also in the use of: glass fiber poles; prestressed-concrete poles; spar-arm construction of EHV wood pole structures; d-c transmission; digital computers for evaluating transmission line losses; aerial versus underground primary and secondary distribution; business machine cards for trouble records as well as other records.

TRANSFORMERS

DURING 1957, the use of both digital and analog computers was extended in the design of transformers and reactors. This was done on the actual design and also on investigation of various special items such as impulse voltages, stray losses, etc. The use of these computers makes it possible to produce better more consistent designs in shorter time.

The study of sound levels in transformers progressed with manufacturers completing or planning additional anechoic laboratories. One of these manufacturers (GE) has developed a preassembled sound enclosure which can be assembled and shipped with the transformer.

A new type of potential transformer using the solid-insulation principle was developed by Westinghouse, for application on circuits of 92 kv and above. Weight reductions up to 40% were obtained and the requirements of the American Standards Association 0.3 accuracy class on burdens up to 500 volt-amperes at 85% power factor were met.

A development in the large transformer field was the introduction of a new oil-preservation system (General Electric Atmoseal) which eliminates air-to-oil contact and permits operation at atmospheric pressure. The new system eliminates the possibility of gas bubble evolution in the oil with possible dielectric breakdown when bubbles collect in regions of high stress. The system uses an impermeable air cell that is vented to the atmosphere and floats on the oil in an oil expansion tank. Variations in oil volume are accommodated by contraction and expansion of the air cell.

The use of lower levels of insulation on the higher-voltage transformers on effectively grounded systems showed considerable gain. Units with 345 kv at 1,050 kv BIL, 230 kv at 750 kv BIL, and 138 kv at 450 kv BIL were being built and put in service.

The two most powerful generator transformers to date, 360,000 kva, built by Westinghouse, were put in service. One was on the Detroit Edison system. This transformer will boost the output of the utility's new 325,000-kw turbine-generator from 17,100 to 129,000 volts. Installed weight is 458,000 pounds. The second unit, rated at 138 kv, was installed on the Commonwealth Edison system.

ROTATING MACHINERY

IMPROVED INSULATION, larger sizes, and improvements in rotor forgings were developments of the past year in large steam turbine–generators.

General Electric's new stator coil insulation for such generators represents the major forward step in providing increased generator reliability and service life. Called "Micapal," this new insulation employs mica mat intimately bonded with a new duplex thermosetting resin. The resulting combination provides a high-voltage insulation with superior mechanical and electrical properties. The first commercial generator employing this insulation is located at the Florida Power Corporation's Higgins Station. This machine is four years old. Further development and extensive use of this insulation took place in the past year.

In 1957, Westinghouse shipped the largest capacity single-shaft generators ever built. They are rated 320,000 kva, 3,600 rpm, 24 kv, 45 psig hydrogen pressure. Two duplicate generators will follow early in 1958. Orders for still larger single-shaft machines have been received with ratings of 352,000 kva and 384,000 kva. These machines are of inner-cooled construction, which will also be used on the largest 4-pole generator which has been on order for some time. It is rated 330,000 kva.

New knowledge and basic improvements, which are of great significance in assuring the safety of rotor forgings, have been reported by GE. The cause of a rotor burst in California has been found in an array of extremely thin, glass-like inclusions, covering a much larger area than had been indicated by previous factory ultrasonic tests. Better evaluation of such inclusions is now obtained by repeating the ultrasonic tests after rotors are run at least to full speed. Bursting tests of large disks cut from actual rotors show conclusively that forging toughness is correlated with the brittle-to-ductile transition temperature determined by impact tests. Tougher forgings with lower transition temperatures are being obtained by modification of alloy content and heat treatment, without sacrifice of other properties, either mechanical or magnetic.

Science and Electronics

COMPUTING DEVICES

THE YEAR 1957 saw increased use of analog equipment in many new fields. Two of these areas of application are simulation of nuclear reactors and jet-engine simulation. Engineers of GE have described a large analog computer designed and built to assist in design and test of these engines.

The major trend in analog computing equipment during the year has been toward increased input–output automation. All of the major manufacturing of general-purpose computers have added input–output facilities to their equipment which accept and produce numerical data. In most cases, this equipment can automatically program the computer and automatically reword solutions. Another equipment development which reached the hardware stage during the year is an analog–digital conversion system, which was installed at a major computing facility on the West Coast. This equipment ties together a large analog and a large digital computer for combined operation.

During the year, major airlines have placed orders for special-purpose analog computers for use as flight trainers. These simulators will assist the airlines in preparing for delivery of jet transports.

In the field of digital computing devices, the most important developments during 1957 were in connection with information storage elements. Business applications require large memories which must be in-

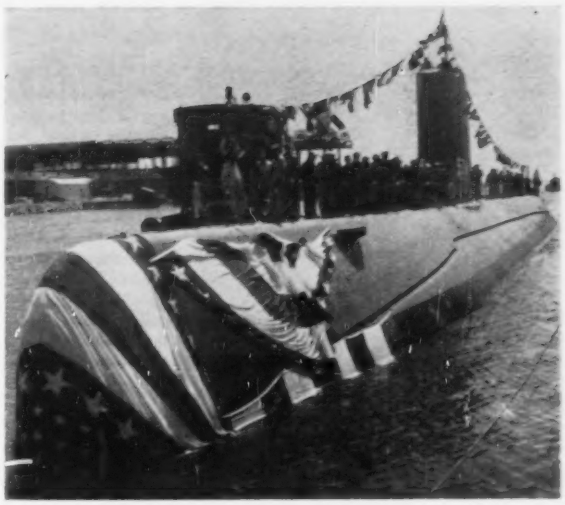
expensive enough to permit economic justification. The advantages of systems operating with random access to any record in storage are being recognized to a greater extent than in previous years. Large random access files, delivered this year to users, were the 20 million digit Datafile (Electro Data Division of Burroughs Corporation) and the 40 million digit RAM (Potter Corporation). Still being tested, both in the laboratory and field, are the 5 million or 6 million digit RAMAC (International Business Machines Corporation), a 2½ million digit drum (Laboratory for Electronics), and the LARC drum (Remington Rand). Announced recently were developments in cryogenic (low-temperature superconductor) storage elements which offer future promise of small inexpensive memories of very large capacities with very high rates of record retrieval.

The publication of a considerable number of papers on specific instruction routines of interest to electrical engineers is an indication of the expanding use of digital computers in the fields of electrical industry and utilities. These specific programs include power system stability problems, calculation of short-circuit currents in large networks, power-flow studies in large networks, computation of driving point and transfer impedances, and induction machinery design.

The realization that reduction of programming time is a necessary step in the more widespread and economic use of digital computers for the solution of "one of a kind" engineering problems is indicated by the continuing intensive work in the field of automatic programming. In this connection, three distinct approaches must be noted: (1) The "co-operative" approach, in which the users of one particular computer type get together to standardize their program writing and agree to exchange their individual programs, such as DUO (Datatron Users Organization), SHARE for 704 users, and USE for Univac users; (2) The more ambitious effort of manufacturers (and some users) to develop compilers, assemblers, and generators to reduce directly the programming time required for their particular machines; and (3) The most ambitious effort, namely, to develop and use a single "Universal" code for any internally programmed general-purpose machine.

SOLID-STATE DEVICES

SIGNIFICANT PROGRESS has been made in the categories of solid-state electronic materials and devices. Silicon carbide semiconductors have been made from the pure elements in the laboratories of the Westinghouse materials engineering department. Hexagonal-shaped crystals ¼ inch across can be grown with less than one part per million of impurities. These are prepared in a specially designed furnace operating at 2,400 C using an atmosphere of superpure argon or helium. Rectifying junctions have been grown in these crystals which will withstand voltages up to 200 volts and carry 10 amperes. The cell operates with a 200 C rise above an ambient of 500 C. This is two to three times higher than any temperature at which semiconductor rectifiers have previously operated.



Courtesy Westinghouse Electric Corporation

View of the nuclear-powered submarine, USS Skate, shown at its launching ceremonies in May 1957. On October 27, after completing successful dockside tests, this submarine put to sea, for builders' trials, with complete success. Two sister ships, the USS Swordfish and USS Sargo, were also launched in 1957, the former in August and the latter in October.

A new device for switching service has been developed by a number of laboratories. The Bell Telephone Laboratories version is the p-n-p-n diode. RCA Laboratories and Westinghouse materials engineering department have a similar device with a modified contact at one electrode. The devices have two terminals and a 4-layer internal structure. Voltage applied in the reverse direction results in a small leakage current up to the breakdown voltage. At this point, the device switches in less than 0.1 microsecond to a highly conductive state. Westinghouse has made an a-c switch for 1 kva operated from CYPAK inputs—a truly static power switching circuit.

The group III-V compound semiconductors are receiving increasing attention. RCA Laboratories succeeded in constructing a high current gain transistor of gallium arsenide employing a gallium phosphide "wide band gap emitter." Westinghouse materials engineering department has produced an indium antimonide infrared detector which employs the photoelectromagnetic effect. The cell is comparable with photoconducting devices with the added feature that it requires no cooling. In addition, the cell has a lower noise figure and shorter response time.

Silicon is the material that has received more attention than any other semiconductor. GE has produced transistor-grade material by a silicon tetraiodide process. Texas Instruments, Inc., is offering transistor grade material for general sale. The Westinghouse semiconductor department, with the Siemens-Schuckert A.G., has produced single crystals with impurities below one part in six billion—probably the purest ever grown.

Courtesy Westinghouse Electric Corporation

Cast epoxy resins are finding increasing use where the number of parts required is low, so that the cost of producing a mold would be prohibitive. Shown are a number of large metal-clad switchgear support housings for a magnetic air circuit breaker.

Many new germanium and silicon transistor types appeared as additions to manufacturer's product lines. Notable among these are the Texas Instruments high-frequency tetrode transistors, the GE 85-watt silicon power transistor, as well as the Delco 1-kw power-switching transistor. Developments in transistor equipment show that no existing electronic system has escaped a feasibility study for transistorization. Many equipments are being produced in volume for general sale.

SEMICONDUCTOR–METALLIC RECTIFIERS

AMONG THE 1957 DEVELOPMENTS in the field of semiconductors was the introduction of larger single crystal rectifier cells in both germanium and silicon types.

At least one manufacturer is producing germanium cells in sizes up to 1 inch diameter and several manufacturers are producing silicon cells of ½ inch diameter. Such cells are capable of carrying currents up to several hundred amperes.

From West Germany comes the news that silicon can now be produced with resistivities in excess of 1,000 ohms per cubic centimeter, a fact which points toward the development of cells having much higher peak inverse voltage ratings in the not-too-distant future.

Research on rectifying materials capable of operation in ambients up to 500 C is receiving increased attention because of military needs. Investigations are being made with various intermetallic compounds. Single-crystal silicon carbide cells have been made experimentally and operated in ambients in excess of 500 C. However, there is still much to be learned in the techniques of growing single-crystal silicon carbide.

Rectifier equipments utilizing both germanium and silicon type rectifier cells are being manufactured in increasingly larger capacities. One recent installation was rated 140,000 amperes at 250 volts, 35,000 kw.

ELECTRONICS

THE PAST YEAR saw tremendous expansion in the application and acceptance of the transistor, of which about 30 million units were manufactured. Research and development efforts resulted in improved fabrication techniques for silicon, in successful operation of higher frequencies, powers, and temperatures, and in new devices. Several improved fabrication methods were developed, including the use of photolithographic techniques which allow the transistor to become an integral part of a printed circuit.

Better understanding of the solid state has enabled development to begin on light amplifiers, cooling devices utilizing the Peltier effect, and high-frequency low-noise amplifiers based on magnetic spin resonance effects.

Some 5,000 digital computers, representing 100 commercially available types, were in use. Significant progress was made in high-speed output devices for these computers. Much rewarding effort was expended on logic and memory units including multiple flux path core units, cores with printed windings, and superconductive units.

In the field of communications, tropospheric scatter systems continued to gain wide acceptance and single-sideband systems increased in usage. A definite effort was made to apply the principles of information theory to the development of new systems.

The extensive efforts of the past few years to improve the reliability of electronic systems led to their increased acceptance in industrial control systems. The missile and satellite programs, among others, produced increased emphasis on telemetering and automatic data reduction systems making wide use of magnetic tape recording.

The field of medical electronics continued to expand, resulting in radically different and improved diagnostic and surgical techniques. A revolution in music may result from a perfected laboratory assembly of oscillators and magnetic tape units attached to a special keyboard and capable of producing, singly or in combination, the sounds of all known or imagined musical instruments.

MAGNETIC AMPLIFIERS

THE ACCELERATED USE in combination of magnetic amplifier and transistor elements in 1957 has led to new capabilities, circuits, and functions. During the past year, the outstanding progress in magnetic amplifier–transistor combinations was evident from the improvement and application of circuits built around the transistor-saturating core inverter. The inverter, using a saturating magnetic core to switch transistors so that a square-wave alternating voltage is obtained from a direct voltage, became available as a d-c to 3-phase a-c converter. At present, these static converters are replacing mechanical vibrators where long life and improved reliability are important. As higher-powered transistors become available, there is also a trend toward the replacement of rotating alternators. In addition, the alternating output of the transistor-saturating core inverter is used as a higher-frequency supply (1 to 50 kc) for magnetic amplifiers and as a d-c to d-c transformer, wherein the alternating output is transformed to a desired level and then rectified. The development of circuits combining

magnetic amplifiers with transistors operated in the switched mode had particular application in missile work.

In the high-power field, magnetic amplifiers in the range of tens to hundreds of kilowatts have been applied to the regulation of large turbine–generators and synchronous machines. Similarly, with the increased use of semiconductor diodes instead of ignitrons for high-power rectification in the electrochemical field, there was an associated increase in the design of high-power magnetic amplifiers for control and regulation of these rectifiers.

Progress was also reported in magnetic amplifiers for operation in high ambient temperatures. Magnetic amplifiers capable of operation at 250 C have been realized. Work was initiated on 500 to 600 C magnetic amplifiers.

In the low-power field, the miniature saturable reactors designed to work with carrier supplies in the 1- to 10-mc frequency range demonstrated their capacity to perform many vacuum tube functions. Where ruggedness and reliability are major considerations, these magnetic amplifiers serve well as input amplifiers, gates, time bases, decimal counters, coincidence amplifiers, and control circuits. The speed and reliability of magnetic amplifiers of this type make them suitable for computer applications.

NUCLEONICS

THE PACE of nuclear power, development, both in the U. S. and abroad, sharply quickened in the year 1957. In the United States, the year was marked by the completion of several reactor projects representing significant advances in the development of nuclear power. Among these were the Sodium Reactor Experiment (SRE), the Army Package Power Reactor (APPR), the nuclear propulsion plant for the *USS Skate* (SFR), and the Pressurized Water Reactor (PWR) at Shippingport, Pa. In Europe, work was well advanced on a number of research and test reactors, notably in France, Italy, Belgium, West Germany, and Sweden. And, in each of these countries, plans were firmed up and work was started on at least one power reactor as part of the EURATOM program. The power reactor program in England moved into high gear with two plants in operation, three plants under construction, and a fourth ordered. In Canada, a new and improved heavy-water moderated materials testing reactor designated the NRU was placed in operation. The Canadian power reactor project, NPD, was carried forward into the final stages of design.

Initial operation of the PWR at Shippingport at the close of 1957 signaled completion of the first full-scale nuclear power plant in the United States. The plant has a rated electric output of 60 mw and utilizes a light-water moderated and cooled reactor.

Following initial critical operation in April, the SRE began supplying small quantities of power to the Southern California Edison system. The SRE is a sodium-cooled graphite-moderated reactor with a rated electric output of 6.5 mw. It is intended to serve as a pilot plant for a 75-mw nuclear plant planned for construction in Nebraska under the Atomic Energy Commission's Power Demonstration Program.

Extended full-power operation was attained by the APPR at Fort Belvoir, Va. This reactor, which has both civil and military potentialities, is of the pressurized water type with an electric output rating of 2,000 kw.

The U. S. Navy's third nuclear-powered submarine, the *USS Skate,* put to sea under nuclear power in October 1957. It is the forerunner of a group of five fleet-type submarines being constructed as part of the Navy's program to convert all combat ships to nuclear power. The power plant of the *Skate* is similar to that of the *Nautilus* but has about one half the output in conformance with the smaller size of the fleet class submarines.

Most of the research and test reactors in the European reactor program are of the "swimming pool" type. Both pressurized water enriched reactors and gas-cooled graphite-moderated natural uranium reactors are included in the power reactor program abroad.

The four major nuclear power plants now under construction in England represent a second generation of the Calder Hall type gas-cooled graphite-moderated natural uranium reactor. When added to the output of the Calder Hall and Chapel Cross plants placed in operation last year, the new plants will result in a total nuclear power capacity in England of over 1.5 million kw.

DIELECTRICS

THE PAST YEAR has been one of steady progress in a number of areas in the field of dielectrics and insulation. Perhaps the most important progress has been made in the insulation temperature standards. Recognition of the fact that insulating materials should be classified on the basis of thermal evaluation test procedures rather than chemical composition has resulted in the recent revision of AIEE Standard No. 1, entitled "General Principles Upon Which Temperature Limits Are Based in the Rating of Electric Equipment." The Committee on Dielectrics has co-operated with AIEE Standards Co-ordinating Committee No. 4 in this important project.

Considerable progress has also been made in the gaseous dielectrics area where recent studies have improved our understanding of electric breakdown phenomena in electronegative gases such as SF_6 and the fluorocarbon gases, now of considerable interest for application in transformers. In the liquid dielectrics area, a monograph covering this important subject is being sponsored.

Progress is continually being made in the solid dielectrics area, especially through the introduction of new materials and the improvement of the older materials. Important advances have also been made in the development of standardized test procedures for the thermal evaluation of insulating materials and resistance of materials to corona and nuclear radiation.

Fundamental Aspects of Lighting

H. L. LOGAN
FELLOW AIEE

A demonstration laboratory has been set up by the Holophane Company, Inc., for the purpose of teaching the fundamentals of light control. Demonstrations show the "why" of lighting levels, the "how" and "why" of quality in lighting, the principles in the design of visual fields and the use of color, and methods for directing and controlling light to make seeing efficient and easy.

THE FUNDAMENTAL PURPOSE of vision is to gain information about the external world needed for the safety, health, and activities of people. This information is reported to the individual in the form of visual signals (luminous radiation), that are transformed within the person into pulsations on the nerve extensions of the light-responsive retinal elements (rods and cones).

These pulsations operate mechanisms at their destinations. If their destination is the cortex of the brain, they result in visual images and intellection. If it is the motor or regulatory systems of the body (muscles or glands), they influence the activity states of these systems and result in feelings or emotions.

Whether the information is consciously received along the line of sight (the avenue of attention), or is received peripherally without conscious awareness, information is received from the entire field of view as long as the eyes are open and the observer is conscious; and this information is acted upon within the body (Fig. 1).

As an indication of the close connection between bodily activity and visual stimulus, it is virtually impossible to go to sleep with the eyes open. The constant flood of radiant energy pouring into the open eyes, from the entire environment, maintains a high level of bodily activity.

As long as it costs money to provide lighting for man's indoor activities and for his outdoor night activities, it becomes desirable to develop application techniques that will reveal the maximum relevant information existing in a given field of view, at the least expense. It should be borne in mind that the "maximum relevant information" includes not only that needed by the observer to operate his consciously directed activities, but also that needed to establish desirable emotional states, such as feelings of comfort, ease, and security.

There is no way at present of determining the total relevant information that is potentially recoverable in a given field of view and comparing it with the percentage that can be recovered under various lighting conditions, but partial solutions are available.

For example, general experience demonstrates that with more light, more can be seen; either because details can be identified more rapidly, or smaller details can be recognized, or motion in peripheral zones more quickly detected. The change of speed in seeing with increased light is shown in Fig. 2.

More can also be seen with better contrasts. This is illustrated in Fig. 3 where the white beads are almost invisible against the white background but clear against the black.

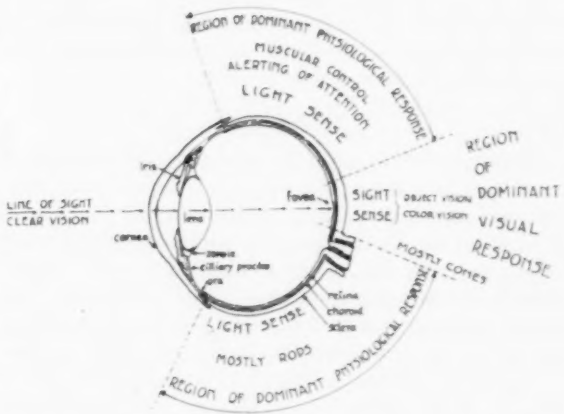


Fig. 1. A section through the human eye, illustrating areas of dominant visual and dominant physiological response.

Factors used in connection with "quantity" of light are time, size, contrast, and the condition of the observer. At present, although lighting engineers are aware that pre-exposure states may influence the response of an observer to a visual field, and that many people have eye defects, they ignore pre-exposure states for obvious reasons, and confine themselves to acting on the assumption that the people who will use the lighting systems they design either have no visual defects, or that their defects have been corrected to normal.

In order to determine scientifically the illumination level required for a given visual task, it is necessary to know the size of detail that is characteristic of the visual task, as well as its contrast with the background.

Both the size of the detail and the reflection factors of the detail and its background can be measured in the field with an illumination levels indicator, such as the

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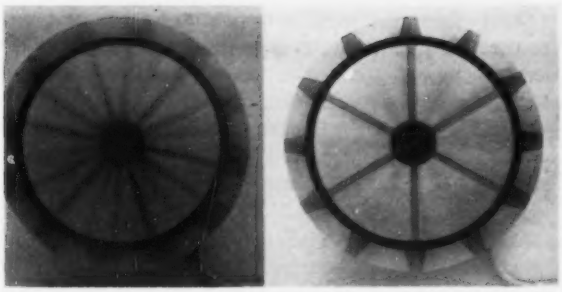


Fig. 2. The change in apparent speed of a rotating wheel under low and high lighting levels. Wheel appears to rotate fast under low light (*left*), and seems to slow up considerably when the lighting level is raised (*right*).

one shown in Fig. 4. The more light people have, the better; but the lighting level in any particular situation is based on the fact that people can afford only so much. The illumination levels indicator shows three lighting levels for each situation, on the basis that 90% of the maximum possible visual performance is the lowest that should be bought for work or school purposes, and that 100% visual performance is usually too costly. These three levels are those for 90%, 95%, and 98% visual performance rates.

It is significant to note that most current lighting codes, developed by the intuitive approach, recommend lighting levels which, when checked by the scientific method, turn out to permit from 95 to 98% of maximum visual performance.

Although the presence of light is essential to permit an observer to receive visual information from a field of view and the quantity of light, all other things being equal, will determine the rate at which we can see, "quantity" alone is not enough. There is plenty of light in a fog on a snow field in the daytime, but the only information the observer can get about the field of view is the presence of light. In order to get more information from the field of view, there must be both qualitative and quantitative contrasts. There must be differences in amount of light in various parts of the field of view and differences in color.

Thus, given a quantity of light, the precise distribution of that light will determine both the kinds of categories and the quantity of information in each category that can be recovered from a field of view. "Bland" fields of view with low contrasts will convey less information than "sculptured" fields with wide contrasts; but there is also a top limit to the desirable contrasts.

Inasmuch as we are natural creatures, the basic assumption is that the range of distributions of natural lighting associated with the narrow band of climatic conditions that are optimal for human beings is desirable to follow. Fig. 5 illustrates this range of distributions. The two heavy lines that cross the flux diagram show the maximum and minimum relative quantities of light, for each zone of the field of view, that have been adopted as the guiding proportions in this method of designing the field of view.

In the Holophane Light and Vision Institute, the principles employed in designing lighted fields of view are summarized in three stages of a lighting installation, shown in natural colors, with three corresponding distribution charts.

Because it is not feasible to introduce color into this article, a two-stage explanation will serve. The two heavy lines that cross the diagram in Fig. 5 are used as guide lines in the three-dimensional design of the distribution of light in artificial fields of view. A spherical protractor (Fig. 6) is applied to an architectural plan and section of the interior to be studied, and a typical drawing of the result appears in Fig. 7. Based on this drawing the average brightnesses of all surfaces are determined by the interflection method; and the brightnesses of the lighting units as they will appear to the standard observer in the standard position are noted. Knowing the brightnesses and areas of all surfaces (which can be obtained from the completed drawing), the relative amount of light present in each visual zone is computed, and the corresponding distribution diagram drawn. The distribution for the interior shown in Fig. 8 is given in Fig. 9.

As the distribution in Fig. 8 is outside the "guide lines" in three of the six zones of the chart, it shows a distribution that is dissimilar to the natural models. It can be expected, therefore, to be beyond the range of optimum adaption of the average observer and to offer more difficulty to the gathering of relevant information than occurs in optimum natural fields of view. Specifically the UM (upper monocular) zone shows 40% more light than is justified by the total amount of light throughout the field of view. It is somewhat similar to permitting a noise level that is too high in a sound transmission system.

This unsatisfactory distribution has been improved.

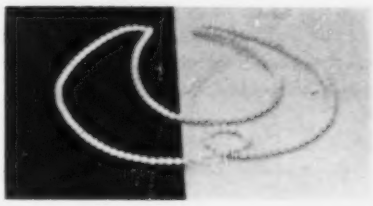


Fig. 3. White beads shown against dark and light backgrounds.

Fig. 4. Illumination levels indicator.

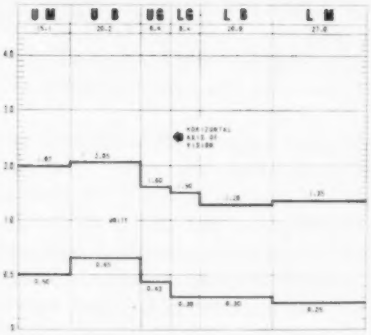


Fig. 5. Distribution for natural lighting.

as shown in Fig. 9, by changing the interior finishes. The distribution of light in an artificially lighted field of view is a result of both the way in which the lighting equipment directs or releases light into the space and the way in which the light is reflected back to the eyes from the surfaces it strikes.

In short, the reflection factors of the various surfaces have to be taken into account. The reflection factors used to compute Fig. 8 were ceiling, 80%; walls, 50%; floor, 10%; desks, 10%. The window wall was raised to 60%, the floor to 30%, and the desk finishes to 40%, and the distribution then recomputed. The result was to change the distribution throughout the field of view sufficiently to bring it within the optimum range of the natural models, as shown in Fig. 9. Another effect of this change was to raise the original average brightness of the field of view, from 19 foot-lamberts to 30, owing to the salvage of light previously absorbed; and this rise in average brightness would of itself increase the quantity of potentially recoverable information.

Changing reflection factors means, as a practical matter, changing colors. Hitherto, this has not been considered to come within the scope and competence of an engineer but, as there are only three possible responses to color (like, dislike, or indifference), a color chart for engineers based on the principle of indifference becomes feasible, and has been established.

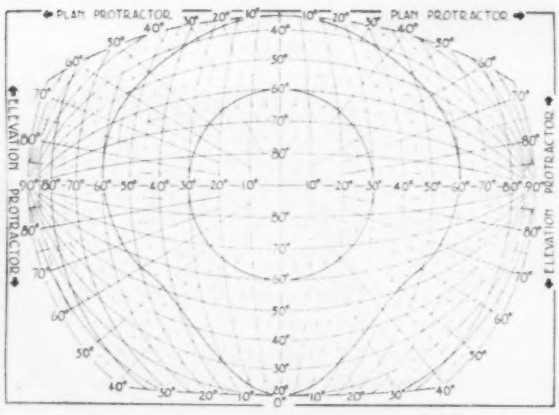


Fig. 6. Spherical perspective protractor.

Colors from the "indifferent" group are satisfactory for the manipulation of background brightness by engineers, in spaces intended to be occupied by groups for work or study purposes (factories, offices, schools, etc.).

Other factors that influence the kind, rate, and quantity of information that is recoverable from an artificially lighted visual field are grouped under the heading of "quality of lighting."

The check on the predicted general distribution of light throughout an interior, illustrated in Figs. 5 to 9, establishes what the British call "bulk brightness" distribution. It determines the interzonal variations to be expected but tells nothing of the intrazonal variations, or the brightness peaks and valleys, popularly called "glare" and "shadows." Both glare and shadows interfere with the receipt of information along the line of sight when intercepted by the line of sight and, when

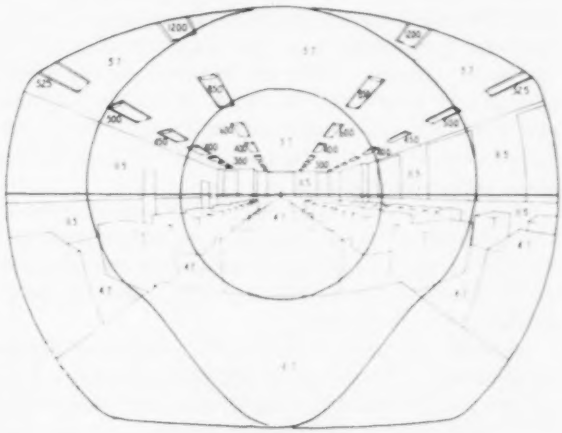
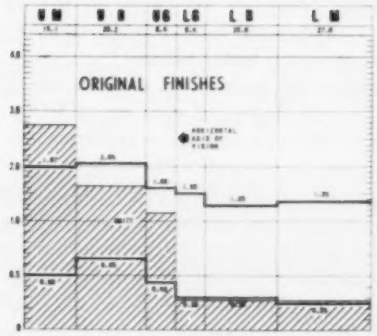


Fig. 7. This diagram, because of the method of projection, is an accurate drawing from which engineering quantities can be taken. From it, the visual area of all significant surfaces in the room is obtained.

off the line of sight, out to at least 30° radially from the line of sight. That is, within this cone around the line of sight they directly interfere with the receipt of data for intellection. When outside this cone, they still influence the emotional response of the observer to the lighted scene through the peripheral mechanism, as mentioned previously.

Any interference with the kind of information needed from a field of view, or with the quantity needed, or with the rate at which it can be received disturbs the observer. Insufficient light shows up as fatigue, resulting from tensions caused by the slowing up of perception and the muscular effort required to bring objects close to the eyes for the recognition of detail. Non-revealing shadows cause a sense of insecurity or frustration. Absence of shadows shows up as errors in space-time judgments, and an enervation of the nervous system caused by the lack of interest in "bland" environments. Glare shows up as visual discomfort.

Visual comfort tables are now available as a guide to current types of lighting that are least likely to cause



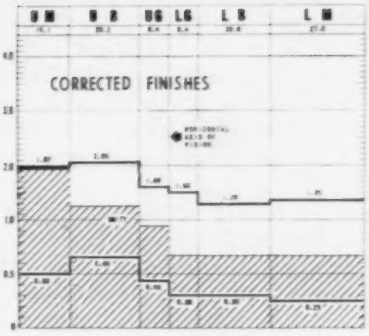


Fig. 8 (left). Unsatisfactory lighting distribution. Shaded areas show conditions in a typical installation being tested for correction by this system. Fig. 9 (right). Satisfactory distribution. Shaded areas indicate improved distribution in same room after reflection factors were corrected by proper decoration.

annoyance as a consequence of continued exposure to them. A typical visual comfort table is shown in Fig. 10.

Referring back to the lighting design shown in Fig. 7, it may be noted that this diagram includes the brightnesses of the lighting units. Their size can be measured with sufficient accuracy by a planimeter on the original drawing, and their positions relative to the observer can be determined by inspection. Using this data to compute the visual comfort relations, a prediction for this interior is that 50% of the observers that could occupy the worst position would feel uncomfortable, at the original level of adaptation for the interior of 19 foot-lamberts. However, with the change in interior finishes that raised the adaptation level to 30 foot-lamberts, the percentage of comfortable observers would rise to 75%. This percentage could be raised again if means were adopted to reduce still further the relative proportion of light reaching the eyes of observers directly from the lighting units. One means would be to select equipment with less light emitted from the horizontal down to 60° from the vertical.

This point is illustrated by Fig. 11, which shows three photometric distributions; namely, complete diffusion, partial diffusion, and a controlled distribution. Curve B, showing complete diffusion, will emit 25% of its total output in the 60° to 90° zone, where it cannot be dodged by the observers' eyes, and another 25% in the 45° to 60° zone, where such light will be directly encountered by the eyes part of the time. In short, this type of distribution, which is characteristic of much present lighting practise, delivers 50% of its total output in directions that cause glare all or part of the time.

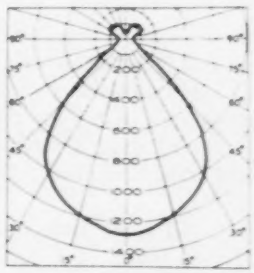
Curve C shows partial diffusion, with emission of 15% of glare light in the 60° to 90° zone, and 22% of partially glaring light in the 45° to 60° zone, or a total of 37% of light that causes glare all or part of the time.

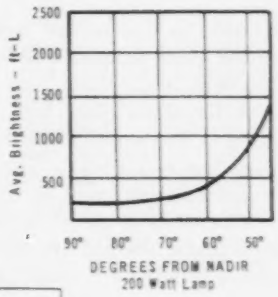
Curve A shows a controlled distribution in which the light emitted in the 60° to 90° zone has been reduced to 9%, and to 17% in the 45° to 60° zone, or a total of 26%. Lighting units having distributions of this type will permit the design of installations having visual comfort factors of 90% or better.

The photometric distribution of the equipment used in Fig. 7 is similar to curve C in Fig. 11. If the distribution was changed to something similar to curve A, the visual comfort prediction could rise to 97%.

Lighting fields of view by highly diffused light not only may interfere with best seeing by sending too large a proportion of the light directly to the eyes from the lighting equipment, but also may interfere with the receipt of information from the field in other ways. For example, the shapes of the three objects in Fig. 12 are difficult, if not impossible, to assess accurately, as a result of the bathing of these objects in diffused light. The same objects, lighted by controlled light in which much of the randomly directed light is prevented, are easy to recognize in Fig. 13.

The degree of diffusion in the light has an important





VCF Values for 200 Watt Lamps					
Room Width	Room Length	Ceiling Height (Ft.) 8½	10	13	16
15	20	100	100	100	97
	30	100	100	100	97
	40	99	99	99	96
	60	98	98	98	95
20	20	100	100	100	96
	30	99	99	99	95
	40	98	98	98	94
	60	97	97	97	93
	80	96	96	96	92
30	40	97	97	97	93
	60	96	96	96	92
	80	95	95	95	91
	100	94	94	94	90
40	40	95	95	95	91
	60	94	94	94	90
	80	93	93	93	89
	100	92	92	92	88
60	120	90	90	90	86

VCF Values for Other Lamp Sizes Compared to VCF Values for 200 Watt Lamps

Lamp Size – Watts		
150	200	300
99%	95%	87%
96%	90%	81%
92%	85%	75%
88%	80%	65%
84%	75%	55%

Fig. 10. Visual comfort factor, 25 to 100 foot-candles. Reflection factors: ceiling, 80%; walls, 50%; floor, 30%.

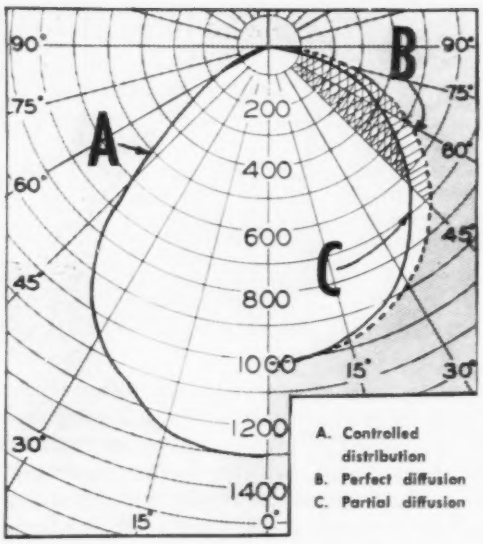


Fig. 11. Three photometric distributions.

relation to one of the aspects of reflected glare. Reflected glare presents a different and more subtle problem than direct glare. There is a fairly satisfactory yardstick for direct glare, but nothing comparable for the pinning down of the effect of reflected glare. Reflected glare has two aspects. The most important, and least realized, is illustrated in Fig. 14.

This effect is called "dimage," and is the reduction in contrasts caused by the diffused image of a light source falling on a visual task. It reduces visibility, but because it may occur over wide areas, it may not be obvious and often escapes detection. It is clearly visible in the illustration, as a portion of the newspaper was shielded in order to prevent dimage on the left part, permitting a comparison to be made. The experimental setup was designed to bring out the effect sharply, so that the effect in the illustration is greater than usually will be encountered in actual installations.

In general, the higher the percentage of diffusion in the light, the greater the degree of dimage to be expected. The degree of diffusion in light is an important factor in the kind of use the eye can make of light.

The anatomical structure of people is no protection against the flat angle light of low sun travel, against the flat angle light from overcast diffusing skies, or against artificial light from similar directions. Man's eyebrows, his opaque forehead, and the top of his head protect him against sun travel in the arc of 35° from the vertical. This fact suggests that man originated in the region of earth where the lowest arc of sun travel is 35°, or thereabouts, from the zenith. This agrees with the general conclusion today that man originated somewhere along the 70 F annual isotherm where it crosses land masses, or roughly between 30° and 35° north latitude.

Apart from the unbalanced distribution of light that is characteristic of excessive diffusion, that is, apart from the excessive proportion of flat angle light in such distributions, the visual system is not equipped to extract the necessary information from a field of view lighted by total "shadowless" diffusion. "Shadowless" lighting is held to be ideal by some people because its uniformity is comfortable, just as a general, moderate noise level may be comfortable, and preferable to silence; but just as this noise level may mask sonic information, so also does the "noise" of diffusion mask visual information, as illustrated in Fig. 15.

Fig. 14. Demonstration of the effects of dimage. Left portion of newspaper is shielded to prevent dimage.*

Fig. 12. Three objects under diffused light.

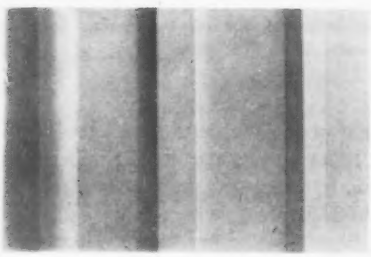


Fig. 13. Three objects under controlled light.

The second aspect of reflected glare, in which an image of a light source is reflected from the working area, is called "distraction." The distraction effect is obvious. It is deliberately sought in some situations where it can be an aid in detecting flaws in shiny materials. In general, it is not an aid, but tends to mask the details the eye is trying to see; or when it is not directly on the work, but nearby, it tends to lead the eye from the task by its phototropic effect. Obviously, where there is a choice of surface finishes, as usually there is, shiny surfaces should be avoided in work areas.

* Control and Measure of Directional Flux at the Task, C. P. Wakefield. *Illuminating Engineering*, Baltimore, Md., vol. 48, no. 5, 1953, pp. 124-33.

Shadow is another of the "quality in lighting" factors that has not been satisfactorily pinned down. The general statement can be made that shadows interfere with the revelation of visual information when they are too dense to see into, or too faint to shape form or

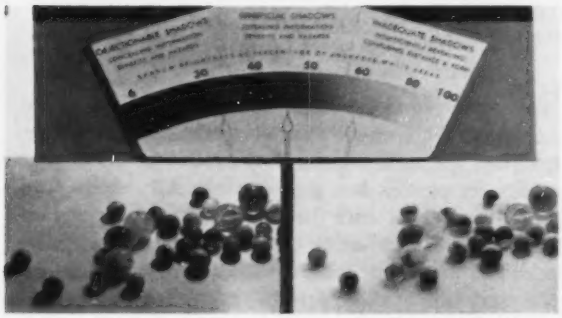


Fig. 15. The effects of shadows. Panel on the left shows dense concealing shadows; panel on the right shows moderate revealing shadows.

mark distance distinctly, but there are exceptions. Sometimes, for example, the direction in which the shadow is cast, independent of its relative density, may determine whether it interferes with or assists vision.

A quantitative check of shadow densities versus their role in concealing or revealing visual information, reported to the International Congress on Illuminating in 1955, indicated that shadows should be approximately 40 to 60% as bright as the unshaded areas surrounding them. This is illustrated in the photographs of Light and Vision Institute demonstrations in Fig. 16.

run largely in the direction of (1) greater efficiency in the conversion of electrical energy into luminous radiation, thus permitting higher levels of illumination with clearer revelation of the field of view; (2) better color of the emitted light leading, to more faithful rendition of the appearance of things; and (3) longer useful life, which helps to lower cost.

With respect to the accessories, the improvements have moved in the direction of (1) more varied types of control of the emitted light, permitting the lighting pattern to reveal more effectively the special features that should be recognized in particular fields of view; (2) more accurate control to reduce glare and increase output in preferred directions; and (3) mechanical improvements that reduce capital costs, installation costs, and maintenance costs. Fig. 16 shows some of the light control demonstrations in the Light and Vision Institute.

While, as stated earlier, there is yet no quantitative measure of the over-all relevant information potentially recoverable from an artificially lighted field of view and no quantitative measure of the information actually revealed under various conditions, some quantitative knowledge of the effect of the various factors acting independently of each other is available. For example, some data is available on the effects of the quantity of light; also on the effects of the distribution pattern, direct glare, reflected glare, and shadow. The choice of the best lighting system for a given field of view (office, store, machine shop, gymnasium, etc.), therefore, becomes a matter of intuitional optimizing on the basis of economic equilibrium. That is, it becomes a matter of judging empirically the value of various degrees of

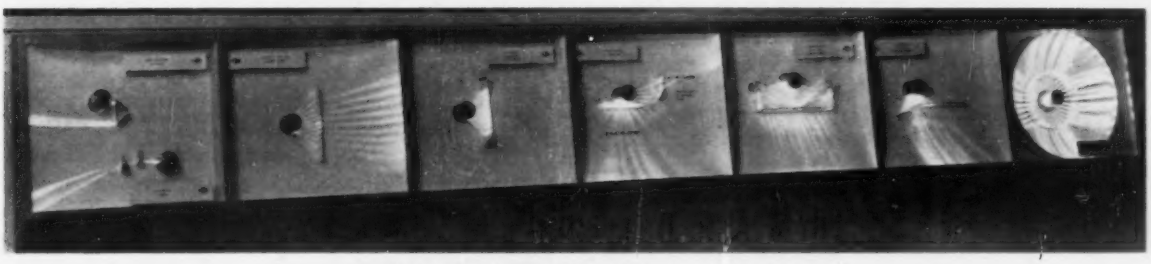


Fig. 16. Sections of commercial refracters controlling light.

As pointed out by Mertz,* ". . . there are two aspects to the development of communication systems," namely the invention of the fundamental equipment and the analytical study of the use to be made of the equipment, with its "feedback" effect in optimizing the equipment. This is also true of lighting systems. Artificial light sources and their accessories were first invented. Then their effects in revealing a field of view were analyzed. Finally, the equipment has been improved in the light of the analytical study of its effects. With respect to light sources, the improvements have

application of the factors mentioned, in the light of the cost needed to attain those degrees of application.

For the benefit of readers who feel the author has ignored aesthetic factors, it should be pointed out that this comes under the heading of "emotions," as referred to at the beginning of this article. Lighting systems should be designed to excite satisfactory responses in this connection. There is a category of aesthetic data that should be designed into the environment, into the lighting system to the extent that it is a visible feature of the environment, and into the application of the lighting system so that it reveals the essential aesthetic data.

* Information Theory Impact on Modern Communications, Pierre Mertz *Electrical Engineering*, vol. 76, no. 8, Aug. 1957, pp. 659-64.

The Growing Importance of Ethics to Engineers

P. L. ALGER
FELLOW AIEE

Ethical standards change with the times, thus guiding the widely different ideals and needs of people into channels beneficial to all. Ethical conduct is the necessary middle road between man's natural inner pressure of selfishness and society's outer pressure for unselfish behavior.

IN THIS ENGINEERING AGE of automation and television, we are concerned with programs and forces that bring thousands and even millions of men into partnership. High ethical standards, and ideals that all can accept, are essential in the conduct of these great projects if harmony and concerted effort are to be secured.

This ethical problem, of reconciling the widely different ideals and needs of all kinds of people, has come sharply into focus as the direct result of the success of engineers in annihilating time and distance. It is natural, therefore, that engineers should have a growing interest in the ethical principles which must guide us in organizing the ever-greater engineering projects that lie ahead.

MAN'S DUAL COMPULSIONS

NATURE has endowed man with a desire to succeed, while society urges him to be good. Thus, he is driven by internal forces to act selfishly, and he is also driven by external forces to act unselfishly. The internal forces are likely to be stronger, so society prescribes rules of ethical conduct, and employs police to enforce them.

Long ago, man found that he must specialize in order to succeed. By acquiring special skills and tools, at the expense of his other affairs, a man can produce more and better shoes, but then he must exchange his extra shoes for the surplus products made by corn and clothing experts. Before this can be done, these men with skills must be able to trust one another, lest some of their vital needs be left unfilled.

Thus, when capitalism began, man found that success no longer came so easily by the "dog eat dog" law of the jungle. He had to be trusted by others if he was to share in the rewards of teamwork. Without mutual trust, each man had to be self-sufficient, and could not reap the benefits of his special skill unless, perhaps, an overlord or the state made justice sure.

Full text of a conference paper presented at the AIEE Fall General Meeting, Chicago, Ill., Oct. 7-11, 1957, at a session sponsored by the AIEE Professional Conduct Committee.

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Over the centuries, man has refined his skills unendingly, and continually redivided the work to be done into more specialized tasks, thus extending his projects over longer periods and greater areas. All this, in turn, has required that men be organized into more and larger clans, communities, clubs, corporations, societies, states, and nations of infinite variety.

In every one of these human organizations, two ethical problems arise. First, how can rules of conduct be devised that will enlist the full abilities and loyalties of the members in making the particular organization succeed and grow? Second, how shall the rules of conduct distinguish between relations within the clan and those outside?

ETHICS WITHIN THE CLAN

THE COMPETITIVE STRUGGLE for a place in the sun being what it is, ethical rules within the family, or corporation, or clan, must be designed to appeal to the selfish interests of each member, so that everyone will put his whole energy into making the clan succeed. Bonuses, profit sharing, perquisites, and honors of many sorts are rewards usually bestowed for signal efforts of individuals in the group interest. The rules need also to guard against a few exploiting the many, for group incentives that promise benefits to each in nice accord with what is due, and for penalties to be meted out to transgressors.

In early times, and in small self-sufficient clans, it was possible to generate a fierce family loyalty in D'Artagnan's spirit of "one for all and all for one," thus assuring maximum effort and internal harmony. In the large organizations of the present day, carrying on complex and far-flung enterprises, it is far more difficult to inspire whole-hearted devotion, and strict rules with penalties for lack of effort are generally employed to supplement the normal incentives. Thus, both the carrot and the stick techniques are used, in varying degrees. However, every man desires to be free to do what he likes, and in his own good time. By doing so, he can fully develop his own abilities, be creative, and contribute the most to the success of the clan—provided that he has the true clan spirit. Every prohibition or limitation of freedom represses initiative in some degree and, therefore, limits progress. Strict rules and penalties take the joy out of work and greatly reduce incentives to creative effort. Hence, large organizations generally do their utmost to see that their members *want* the clan to succeed, and allow them freedom in proportion.

The internal ethical problem in the clan comes down

to the age-old question of how to make men be generous, altruistic, and good to their fellow clan members because they genuinely enjoy being so, not because of any hope of reward or fear of penalty. Any clan, corporation, or country that does not succeed in doing this will fall behind in the race.

The answer to this question lies in reliance upon the power of sympathy, with which nature has also richly endowed mankind. A mother contemplating the suffering of her child suffers also, even more acutely. A teacher, seeing the success of a beloved pupil, feels the keenest pleasure. And all the members of a close-knit family share deeply in the ups and downs of feeling experienced by each of them.

Whenever a group of people work together with a common purpose, therefore, in circumstances that allow each to make a distinct contribution and share fully in the rewards of the group effort, they develop bonds of sympathy, like those in a family. This being so, each will suffer too when any one of them is hurt, and each will enjoy whatever gives pleasure to another. As K. K. Paluev has remarked, the success of large American corporations is largely the result of their having learned how to develop effective teamwork and friendly relations between associated workers, to such an extent that the talents of many are fused into a super individual—a "collective genius"—actuated by a strong clannish spirit. These synthesized geniuses are themselves drawn into association with other groups (in much the same way that protein molecules grow), thus extending indefinitely the co-operative relations of ever larger numbers of men, and correspondingly enlarging the ability of mankind to succeed in ever greater projects.

ETHICS OUTSIDE THE CLAN

IN THE EARLY DAYS, clans obeyed the law of the jungle, just as individuals did at first. It was clan against clan, in the spirit of the Irishman at the fair whose rule was "Wherever you see a head, hit it." As capitalism grew, however, clans as well as individuals became specialists, and they had to gain the trust of other clans in order to reap the benefits of their special skills. Germany without copper, Britain without oil, and the United States without tin are examples of those who have learned the value of friendly relations with countries who can fill their needs.

Before we had radio, or many travelers abroad, it was easy for a good American to be completely unaware of, and callous to, the troubles of a Cairo shopkeeper or a Japanese fisherman—in fact, all the world's troubles outside his own town. Until feeling is conveyed, there is no sympathy. It is easy to hate a man you have never seen, about whom you have been told atrocious things. When you meet and talk with him, or mingle with his family circle, liking takes the place of hate, and you cannot help sharing the stranger's feelings. Ethics begins at home and can extend only gradually, step by step, to those outside the clan.

Thus, the ethical relations between clans as a whole are following the same course as those between members within a clan, but lagging many years or even centuries behind. The lag has been greater, on the whole, the larger the clan size. Ethical relations between nations, for example, are just beginning to become civilized, or at least we hope they are. The road ahead is clear, but progress is going to be painfully slow.

A difficult ethical problem that many organizations are just now coming to grips with is to devise rules of conduct for members in their relationships with outsiders. On the one hand, membership must carry with it certain benefits and fraternal relations—(which provide the incentive to join) that are not granted to outsiders. On the other hand, good relations must be maintained with members of other clans having complementary needs and products. Not long ago, autarchy and isolationism were passionately advocated but, when tried, these roads have led to bitter failure. Nowadays, "most favored nation" clauses creep into treaties, and commercial discounts are extended to favorites, in ways that break down the barriers between the "ins" and the "outs." And, large corporations have found it worthwhile to sublet a large proportion of their work to smaller companies with special skills, or to satellite plants with all degrees of independence.

Everywhere, the empires are breaking up and being replaced by commonwealths, or loosely associated groups, that are tied together by accepted ethical codes and common interests rather than by over-all authority. Everywhere also, diverse kinds and sizes of clan are becoming interrelated by association in common enterprises, so that new commonwealths are growing up from the bottom in great variety. This growth of freedom among and co-operation between clans stems from the same cause as the growth of individual specialists and freedoms within clans. In each case, once a bond of sympathy is established, so that loyalty to the larger interests of the clan or clans overrides purely selfish feelings, productivity and creativity rise in proportion to freedom. Without sympathy, freedom can easily produce chaos, because both clans and individuals may then revert to the law of the jungle, unrestrained by witnessing the sufferings of others.

Attempts are still being made to obtain productivity without granting freedom, and to preserve old privileges that are no longer earned, but these are foredoomed to fail under the modern conditions that the engineer has created. Productivity comes from special skills and tools, which require freedom, sympathy, and mutual trust. Then more skills and tools may be developed, thus bringing more people into friendly cooperation, allowing more freedom and creating more sympathy and trust which, in turn, increase productivity, and so on and on.

ETHICS IN THE AGE OF AUTOMATION

NO ONE PERSON or company or industry or nation is any longer fully self-sufficient. Daily, we are becoming more dependent on each other. We are not conscious of this in a supermarket, where we have the choice of six other brands if our favorite coffee or cereal is miss-

ing. But we are acutely aware of it when the electric power, or water supply, or the daily paper fails. In these cases, we wait helplessly until those skilled in the art restore service. And, it is perfectly clear that the service will not be restored unless and until these skilled persons actually *want* to do so. Any number of VIP's giving orders will be of no avail if there is no one available who both knows how to and wants to do the work.

We may pass laws and apply penalties ad infinitum and still be unable to make skilled persons want to perform set tasks. The more skill is required, the more likely the expert is to be a pernickety person with strange ideas of what reward he should be given for his efforts. And the more we automate our affairs, the more there will be of these pernickety people we shall have to rely upon.

The only solution is to develop good human relations, which means to arrange matters so that everyone shares in the pleasure and rewards of good work, and so that everyone also shares, at least sympathetically, in the suffering that occurs when work is not done well or at all. That is, good ethics are more and more necessary, and also are more and more rewarding, with each step ahead that we take into the age of automation. We need good individual ethics, but we need even more good clan ethics—for companies and unions and nations and races. The engineer, who aids and abets all this specialization and automation, especially needs good ethics—to help his profession gain public confidence, and to help manage projects with which he is concerned as well as for his personal benefit.

WHAT ENGINEERS ARE DOING ABOUT ETHICS

THROUGHOUT THE ENGINEERING PROFESSION, ethical codes and rules for professional conduct are being discussed and revised. The National Society of Professional Engineers (NSPE) has just brought out a brochure entitled "Ethics for Engineers," which contains the Engineers' Council for Professional Development (ECPD) Canons of Ethics (which have been adopted by more than 80 organizations) and a set of rules for professional conduct, largely taken from the ethical codes of the various engineering societies. This contains a foreword by the chairman of the ECPD Committee on Ethics, which, in effect, approves the rules for trial use, and indicates that after due discussion and experience, they may be revised and reissued with formal ECPD approval. This marks an important forward step toward unity in the engineering profession.

The American Society of Civil Engineers (ASCE) has been particularly concerned with advertising for bids for engineering services, and the award of such contracts to the lowest bidder contrary to the Society's ethical code. To meet this problem, the Society has brought out a pamphlet entitled "Negotiated Engineering Contracts Protect Public Interest," which explains why it is not good ethics for engineers to engage in price bidding, and describes the proper procedures to be followed in selecting an engineer. The ASCE is also considering a revision of an article in their code of ethics that deals with advertising by professional engineers, and is studying the difficult problem of registration requirements in connection with the practice of engineering by corporations. This latter subject has been under intensive consideration by the New York Society of Professional Engineers for the past three years.

Last year, the American Society for Engineering Education (ASEE) prepared a brochure on practices in college recruiting, which is the product of many conferences and much thought by both industry and teachers. This brochure will be reviewed by the ECPD at its annual meeting, and it is hoped that agreement may then be reached on its reissue with formal ECPD approval, after incorporating whatever changes may seem desirable as a result of experience in its use during the past year.

A recent NSPE survey has shown that 24 of the 48 Boards of Engineering Examiners are now including ethical considerations in making their decisions whether to grant, withhold, or withdraw a license to practice engineering. The New York Board of Examiners has requested that the NSPE prepare "clear and specific statements of those acts or omissions which shall be deemed unprofessional," for their consideration. This fits in with a project already proposed for the ECPD, to draft a supplement to the Canons of Ethics dealing with ethics of professional practice, for the guidance of Examining Boards.

The ASME has also been active in the field of ethics, giving special consideration to procedures for consulting engineers. And, the ECPD is working on a "case book" that may be used in teaching ethics to college students in the same way that law is taught. Finally, our own Institute has held a series of conferences on ethics over the past several years, at which representatives of other professions have spoken. These conferences have lent support to some of the previously mentioned projects and also have led to several interesting articles that have appeared in *Electrical Engineering*.

SUMMARY

THIS BRIEF REVIEW of activities in the field of ethics for engineers gives further evidence that conduct which was considered ethical some years ago may no longer be acceptable. Along with automation and television have come new and higher ethical requirements, that make it necessary to continually revise and extend our codes of ethics, just as we regularly revise our technical engineering rules.

To anyone interested in gaining some perspective in this matter of ethical conduct, as it has evolved over the years, I recommend the seven volumes of Campbell's "Lives of the Lord Chancellors of England," which came out in 1851. This narrated how it was perfectly proper for the king, or even a lord, to take any man's wife or life to satisfy a passing whim; it was right to hang a man for stealing; and public offices were sold to the highest bidder as a matter of course. Yet, in each case there came

a day when, suddenly, such an act was utterly wrong.

A brief extract from a history of England published in 1745 will make the point clear. Here, it is stated "The punishments inflicted upon offenders of all kinds are much more merciful in England, than in any other part of the known world. Such criminals as are obstinate at their trial, and refuse the plea of answering Guilty or Not Guilty, Pressing to Death is the proper punishment. In such a case the prisoner is layed in a low dark room in the Press Yard at Newgate, his back upon the bare ground, his arms and legs stretched with cords, and fastened to the several quarters of the room. This done, he has a great weight of iron and stone layed upon him. His diet, till he dies, is only three morsels of Barley Bread without drink the first day; and if he lives beyond it, he has nothing daily but as much foul water as he can drink."

In our own country, only 150 years ago, persons were put in jail for the crime of teaching a colored child to read, and we have a long way to go yet before such children can have an education equal to that given to others. The present revelations of unethical procedures that are given so much space in the daily papers show that our national code of ethics is having growing pains.

As engineers, who carry a great responsibility for the safety and technical competence of our country, we should make every effort to keep our codes of ethics, and our conduct, in step with the march of progress.

The Electrical Engineer in the Petroleum Industry

J. M. CROTHERS
MEMBER AIEE

Advances in chemistry, metallurgy, and mechanics and an increasing rate of production have added to the problems and responsibility of the electrical engineer. These problems are defined in a discussion of a petroleum process plant project.

IN RECENT YEARS electrical requirements in petroleum process plants have increased in direct proportion to advances in chemistry, metallurgy, and mechanics. The trend toward greater production in less time has introduced higher voltages, larger motors, and more complicated supervisory and automatic control. This has created additional problems and responsibility for the electrical engineer which may be more clearly defined by following his functions when assigned to a new large petroleum process plant project.

The electrical engineer today works more than ever with the chemical process engineers. He must be able to understand the mechanical flow diagrams and be able to discuss the various features of the process in order to design the required power and control systems. From these flow diagrams he obtains the approximate number and size of the large and small motors and other special equipment such as heaters, cycle-timers, electrically operated valves, and thermocouple systems.

Concurrently, the proposed plot plan is developed and here he assists in locating the incoming power with the required substation and distribution system whether underground or overhead. He locates motor controls and reserves space for electrical equipment in buildings such as control houses, boiler houses, and storage facilities. Here, with the knowledge of the process, he estimates the blocks of power required by process sections or areas and an estimate is made of the lighting requirements. Future expansion is carefully considered and additional space is provided which will not interfere with the process expansion. Hazardous, semihazardous and nonhazardous areas are determined in consultation with process engineers.

TENTATIVE SINGLE-LINE DIAGRAM

SUFFICIENT INFORMATION should then be available to estimate or determine the following:

1. Maximum operating kw, and future kw
2. Distribution system voltages and choice of overhead or underground
3. Motor voltages
4. Estimated power factor
5. Lighting—where floodlights, incandescent, or fluorescent should be installed

Essentially full text of a conference paper presented at the AIEE Conference of the Petroleum Industry, Philadelphia, Pa., Sept. 9-11, 1957, at a session sponsored by the AIEE Petroleum Industry Committee.

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6. Classification of areas—hazardous, semihazardous, and nonhazardous
7. Need for economic studies

A tentative single-line power diagram is made showing the distribution system with the usual relaying, motor control, and lighting transformer.

Detailed discussions are then held with the client for approval to proceed on the foregoing information. Services are offered to assist the client in negotiating the agreements and the final contract with the power supply utility.

These discussions with the power supply utility usually finalize the following:

1. Ownership and responsibility of main substation at plant. Often the utility will want to own and build the main substation and supply the secondary distribution service. The client will then own and specify the main distribution system feeder switchgear. At other times, the utility will terminate the incoming high voltage lines at a point where the client will own, and be responsible for the entire substation. Here also the temporary construction power requirements are discussed and arranged.
2. Maximum kva with consideration of future expansion. Supply characteristics—voltage, phase, cycles.
3. Incoming line—whether single, double, or the desirable loop service can supply from either or both directions.
4. Location of substation and right of way for incoming service.
5. Large motor starting requirements.
6. Short circuit currents at the point of incoming service with consideration of future utility capacity.
7. Grounded or ungrounded plant system. Most electrical engineers now specify delta primary and grounded-Y secondary plant distribution system, and experience indicates that utilities concur.
8. Service dependability—average yearly outages, lightning protection, and any special relaying.
9. Special utility regulations or requirements such as insulation levels, grounding, and spacing. For example, certain utilities, depending on regions, require high creepage insulation on certain types of equipment.

SINGLE-LINE DIAGRAM FINALIZED

With the aforementioned information, the tentative single-line diagram can be fairly well finalized and brought to a workable stage. Motors and various equipment are separated into critical and noncritical process items. Dividing the process into sections, motors can be arranged into various groups and connected to appropriate feeders. Critical process items are grouped on busses which can have alternate or emergency service. Radial, primary selective, or loop systems are studied and the most advantageous system is chosen. Emergency power consisting of a turbogenerator may be necessary, if only for lights, fire alarm instruments, aircraft warning lights, and possibly motor or solenoid operated valves.

Calculations can now be made of short circuit currents, voltage drops, and power factor; the appropriate relays, current and potential transformers, instruments, and cable sizes are determined.

Long delivery items are determined as quickly as possible and specifications prepared for their purchase so that the manufacturer's prints will be available to the drafting department. These items consist of main substation, large motor and motor control, any load center unit substations, high voltage cable, and other special equipment. Expediting the manufacturer's physical and wiring prints is extremely important as drafting is continuing and detailed information is needed. Motor controls present a difficult problem as pumps must be specified prior to motor selections and motors are too often rather carelessly chosen. Enclosures and types are important and inadequate horsepowers are often selected on the low side. The electrical engineer usually pleads for correct information on all motors and especially those having special requirements.

While these specifications and purchase orders are proceeding, the drafting department needs continual assistance with the design, layout, and details, but also with manpower and drawing schedules together with the proper co-ordination of information of the other crafts. Here, a constant study of the process mechanical flow diagrams continues and operating methods and procedures are analyzed to produce elementary control systems to get the proper interlocking and sequential operations with maximum safety. Close co-ordination is necessary between process, instrument, and electrical departments to design the correct control diagrams for automatic safety shut-downs in specific sections. Proper alarms and indications for ease of shut-downs and fast recovery to on-stream conditions are worked into the design. Here, automatic switchover to alternate or emergency power is carefully considered and applied.

Control rooms have become the show place of the petroleum plant. The control room has vinyl or ceramic two-tone tile flooring, the most modern direct and indirect fluorescent lighting, beautiful lighted miniature and standard instruments, red, green, blue, orange, and white indicating lights, annunciators that blow a horn, then twinkle, then steady themselves. A graphic presentation of the process, in all the colors of the rainbow depicting the piping and major items, stretches along several panels finished in apple green or robin's-egg blue. This is a job! Many hours are spent in just deciding "why," and "how" it should be done, and "who" should do it.

Annunciators are separated as other items into process sections. Sound powered telephones for separate units or entire plants are used quite often and serve a good purpose as there is no interference by outside calls. Fire alarms are installed and aircraft warning-lights must be considered. Guard and time-clock systems and lighting protection of high lines, structures, and buildings are often required.

All instrumentation and controls interconnected with instrumentation are separated into process sections.

Each is supplied from a different source—not from lighting service—so that no interference will occur when maintenance of lighting is required. Each process section can be de-energized separately.

Thermocouple systems have developed into quite a specialized art with the use of telephone stepping relays. These relays, when grouped near the thermocouple installations, greatly reduce the number of wires and size of conduits running back to the control house. The two most used systems are the straight indicating pyrometer with the telephone dial and counter usually located on the operator's desk; and the scanning system, mostly used on tube temperatures of heaters. In the latter, the dial, actually driven by a motor, cyclic scans many points, and indicates each separately. These are so connected that a high or low temperature stops the scanner and sounds an alarm. These stepping relays are extremely versatile. In fact, systems have been developed in which, by dialing the proper number, the operator can start or stop motors, open and close valves; actually operate the entire plant but the unions did not like the idea.

LIGHTING A PROBLEM

STRANGE AS IT MAY SEEM, lighting is one of the most difficult problems for the electrical engineer. It is difficult because from the president all the way down to the chemical engineer everyone knows or thinks he knows how to light the plant. They may not know anything about foot-candles, lumens, coefficients of utilization, or read the recommendations of the illumination societies, but they most certainly know all about lighting. Control rooms can be well lighted with recessed units of fluorescent lamps giving the floor or walking area 30 to 35 foot-candles and the panels 50 to 60 foot-candles using control lenses. Fluorescent is also good in the switchgear rooms, offices, maintenance buildings, and warehouses. These new color corrected mercury vapor floodlights do well for parking areas and road lighting. They do very well in all areas having low equipment where shadows can be illuminated. Refineries have crowded structures, vessels, towers, gauges, isolated instruments, and valve areas which cannot be foot-candled.

This is where experience and good judgment places the incandescent units to the best advantage.

RESPONSIBILITIES OF THE ENGINEER

DURING THE PROCESS of planning and finalizing these numerous details, the drawings are progressing and orders must be placed for all the miscellaneous items in order to meet delivery schedules for construction. Meetings with the client are usually necessary to obtain his preference on items such as wire, conduit, fittings, welding, receptacles, service receptacles, plugs, switches, etc., right down to the catalogue numbers. This is important and must be tabulated and issued to the drafting department in order that everyone uses the same items. It complicates things when each draftsman picks different manufacturers for the same items. Standardization is very necessary in all drafting departments, and close co-ordination between all crafts must be maintained.

Manufacturer's prints are also arriving and must carefully be checked and distributed to the interested parties for their information and drafting work. Certain prints must be directed to other crafts in order to complete the over-all design. Wiring diagrams of switchgear, starters, relay cabinets, and other packaged items must be very carefully checked so that the interconnection diagrams can be correctly made.

The electrical engineer usually is responsible for factory inspection of items he specifies. This should include switchgear, starting and control equipment, and any equipment that has complicated wiring and all equipment which must match or be bolted together in the field. Some equipment should be operated at the factory before delivery and should be witnessed for satisfactory operation.

During construction, it is often necessary for him to spend many days and occasionally weeks in the field not only to assist in the interpretation of drawings, to check relay settings, and to describe operation, but also to assist in getting the plant on stream. He is often requested to instruct operators and maintenance men on the salient points of new or complicated equipment. As a matter of fact, the electrical engineer is more likely to know more about the over-all plant details and operation than other crafts, because these plants are electrically operated and he is more familiar with the details of control, alarms, protection, and interlocks.

Perhaps some of you remember when the electrical engineer was requested to hook-up motors, so the operators could start and stop equipment, and to furnish sufficient light for night operation. Alarm systems were fabricated in the field. Motor starter racks were carefully detailed on elaborate drawings, showing all the angles, bolts, nuts, conduit, bushings, and grounding lugs. Instrument panels were panels supporting the instruments which were spring-wound every 24 hours. Some consideration was given to voltage drop, but very little to interrupting capacity or powerfactor. It is remarkable how well plants operated and actually made profits.

The electrical engineer finally convinced the chemical engineer that a float switch had been designed which would start a motor, drive a pump to fill the tank, then stop the motor and pump when the tank was filled. This would save the operator from running out, starting the pump, watching the gauge, stopping the pump and returning to the instrument house. It is stated that that was the wedge which opened the door for the electrical engineer in the petroleum industry. The demands for more quantity and better quality stimulated chemical processes and the entire electrical industry; and personnel engineered, designed, and fabricated methods, systems, and equipment to meet these demands. Prefabricated, then complete packaged units were produced.

Today complete high voltage substations from the

incoming line to the outgoing feeders, including everything from steel structures to anchor bolts, all insulators, switchgear, grounding, lighting, and even the enclosing fence with danger signs are available. It is old-fashioned to detail motor starter racks when motor control centers are available with unlimited flexibility, completely wired and ready for installation. Packaged unit air heaters, water treating systems, instrument control panels, load-center unit substations, air compressor units, cycle-timers, and many other items are standard and can be used as produced, or with minor changes, to suit certain requirements. A thorough knowledge of the various electrical systems in the refinery to satisfy the process is a prerequisite to specifying these packaged units. This is the electrical engineer's responsibility. Where possible, standard items and packages should be used, but where modifications are necessary, improvements and progress should be paramount.

Control circuits involving sequential starting, interlocks, and sequential shutdowns require complicated wiring diagrams. A thorough knowledge, not only of the chemical process, but in many cases, the mechanical features of special equipment is also necessary. Greater production and more closely controlled products have resulted in larger motors, more instrumentation, greater hazards, and more responsibility for each profession involved. Larger motors mean more protection by relay co-ordination and adequate power-interrupting capacity. More rigidly specified products mean more instrumentation with more interlocks and alarm systems. Together these create greater hazards to equipment and personnel, and more sequential starting and stopping systems are needed. Emphasis cannot be too highly stressed for the close co-ordination required of every profession and craft to produce today's well-operated, easily maintained, safe, efficient petroleum plant.

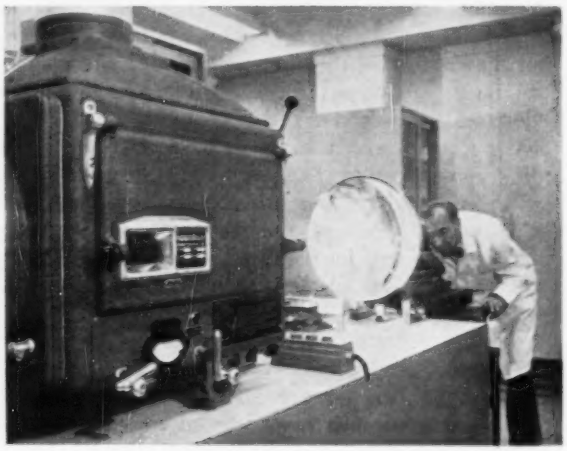
With through-put crude capacities increasing to over 100,000 barrels a day and reactors going to 50,000 barrels a day, all services increase in proportion. It is now not uncommon to have motors in several thousand horsepower for blowers and compressors, and several hundred horsepower for water services. These requirements often increase the voltage from 440 to 2,300, and in certain areas 2,300 to 13,800. Naturally, the higher the horsepower and voltage, the greater is the need for better protection and dependability. We do not carry a spare rotor for a 3,000-hp motor, yet the cost of an outage of a 50,000 barrel a day unit is somewhat higher than an outage of a 20,000 barrel a day unit. Interlocking for proper sequential starting and stopping and automatic safety shut-down of these large units must be reliable.

Electronic devices designed for aircraft, radio, computers, and television are currently being analyzed for use in petroleum, chemical, and nuclear projects. Some have been applied with success, such as sensing devices for changes of temperatures, pressures, flows, and levels to adjust sensitive control equipment.

The extent to which applied nuclear technology will change the petroleum industry in the future is, at present, unpredictable. Chemical reactions are being carried out carefully by controlled temperatures and pressures in the presence of specific catalysts. We know that atomic radiation, especially electron radiation in the form of electron beams will produce reactions, but our knowledge is still very limited. This field is mostly a laboratory assignment. The next few years should bring together nuclear and electronic power combined with instrumentation to produce an increase of at least 50% more products and services with only 10% more effort. This must be accomplished. Talk now is of a four-day work week. The answer must be more automation. The electrical engineer may see into the future when the petroleum plant will be loaded with electronic devices; automatic digital computers redesigned to send control signals from precalculated programming tape; sensing devices to adjust speed of production; automatic monitoring of product analysis, and a host of unpredictable controls.

Established correlation between research, electronic, nuclear, and power teams should produce more and better things than we have ever known.

Mirrors Duplicate Sun's Heat



Temperatures almost as hot as the sun's surface have been produced with standard motion picture projection equipment. Scientists engaged in high-temperature studies at the Research Laboratories of National Carbon Company, Division of Union Carbide Corporation, have developed an arc image furnace that uses a carbon arc to produce a small but extremely high-energy-level beam that can heat materials to temperatures above 7,000 F. The technician is using a high-temperature microscope to see what is happening as a material under study is heated to extremely high temperatures by the arc image furnace, which is an extremely versatile research tool.

Second Order Saturated Servomechanisms

J. W. DIESEL
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A PRIMARY REQUIREMENT in many positioning systems is that errors resulting from large input disturbances be reduced to tolerable values as quickly as possible. For a linear system, this requirement could be satisfied by making the ratio of torque to inertia sufficiently large. However, even with the best servomotor design, this ratio is limited; therefore, to reduce the response time sufficiently, the designer frequently must contend with saturation in the system components and resulting saturated values of available torque.

If saturation effects are present in a given control system, optimum response in the sense of minimum recovery time is obtained if the corrective torque is allowed to saturate at its maximum permissible value during recovery from the disturbance, so that full available power is utilized at all times. In order to avoid excessive overshoot, it is also necessary that the direction of torque be reversed at the proper instant during recovery, so that the error velocity will become zero simultaneously with the error in position. The proper instant of torque reversal is determined by a computer, which utilizes information obtained from the input and output, and manipulates the corrective torque accordingly.

The required computer characteristics established in this paper are applicable to second-order systems excited by inputs consisting of combination velocity and displacement steps. It is assumed that there are no spring forces in the system, so that the servomotor torque depends only on the control voltage m and the output speed c'. The speed-torque characteristic corresponding to maximum torque may then be represented by an expression of the form

$$c'' = \phi\,(m_{\max},\, c')$$

where c'' is the output acceleration, and $\phi\,(m_{\max},\, c')$ is an arbitrary function of the output speed c'. It is observed that this definition includes the broad class of nonlinear speed-torque characteristics of such servomotors as are used in control systems of the standard type.

In order that the corrective torque be manipulated in an optimum manner, the error e, the error rate e', and the input velocity r' are fed to a computer which then determines the quantity

$$f(e,e',r') = e - \hat{\delta}\int_{\delta r'}^{\delta r'-\delta e'} \frac{\delta r' - v}{\phi(+m_{\max},\, v)}\,dv\,,\quad \hat{\delta} = \begin{cases} +1, & e' > 0 \\ -1, & e' < 0 \end{cases}$$

This computed quantity is then used to actuate a polarity sensitive relay with output $\pm m_{\max}$ determined by the algebraic sign of $f(e, e', r')$. The relay output is

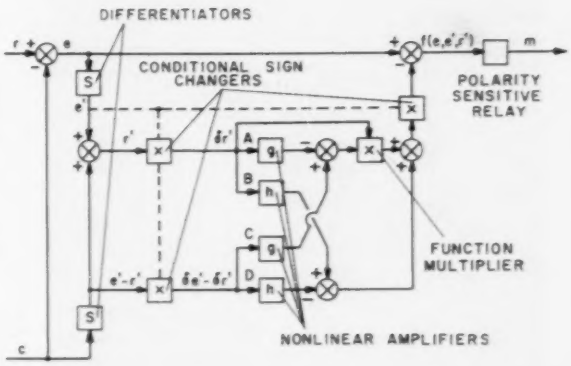

Fig. 1. Schematic diagram of computer required for optimum control.

then used as the control voltage of the servomotor. When controlled in this manner, the response of the given system will be optimum to step displacement and velocity inputs.

The computed quantity $f(e, e', r')$ may also be expressed as

$$f(e,e',r') = e - \hat{\delta}\left\{\delta r'\left[g(\delta r' - \delta e') - g(\delta r')\right] - \left[h(\delta r' - \delta e') - h(\delta r')\right]\right\}$$

where

$$g(u) = \int_0^u \frac{dv}{\phi(m_{\max},\, v)}\,,\quad h(u) = \int_0^u \frac{v\,dv}{\phi(m_{\max},\, v)}$$

From these expressions it is seen that the one way to compute $f(e, e', r')$ is that indicated in Fig. 1. It is interesting to observe that the required nonlinear amplifier characteristics $g(u)$ and $h(u)$ may be found directly from the full control voltage speed-torque characteristic of the plant. This curve is the only information concerning the plant necessary for synthesis of the required computer.

In many applications, simplifying approximations might be used to determine a less elaborate computer than that indicated. The foregoing expressions are, nevertheless, significant in that they exhibit the possibility of determining $f(e, e', r')$ using only existing computer techniques.

Digest of paper 57-1036, "Extended Switching Criterion for Second Order Saturated Servomechanisms," recommended by the AIEE Feedback Control Systems Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Fall General Meeting, Chicago, Ill., Oct. 7-11, 1957. Scheduled for publication in AIEE *Applications & Industry*, 1957.

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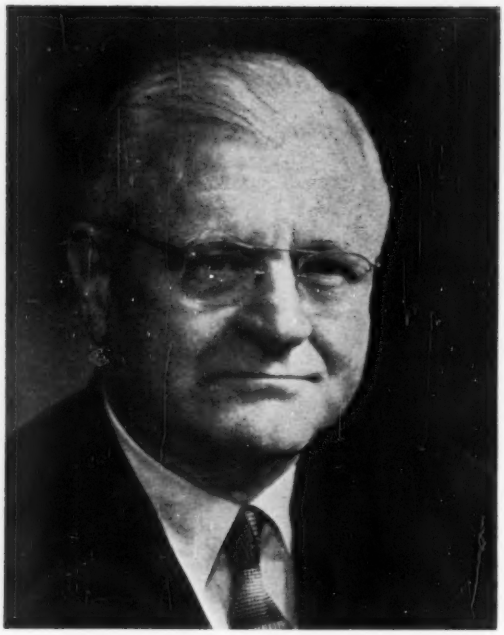

The Builders of Engineers' Council for Professional Development

C. E. DAVIES
FELLOW ASME

Mr. Davies, retiring after 23 years as Secretary of The American Society of Mechanical Engineers, describes the evolution of ECPD, which has become an important instrument serving the engineering profession. The organization has made considerable progress in the administration of a coherent, unified program of continuous growth for the young engineer.

THE FORMATION of the Engineers' Council for Professional Development (ECPD) in the Fall of 1932 resulted from the impact of two chains of events under way within the engineering profession.

In the year 1922, one chain of events started at the Society for the Promotion of Engineering Education (SPEE), which was the forerunner of today's American Society for Engineering Education. The initial impetus came when Charles F. Scott, in his presidential address, asked, "What can SPEE do to develop, broaden, and enrich engineering education?" A board of investigation and co-ordination was appointed with Mr. Scott as chairman. Funds were secured, and William E. Wickenden was appointed director in November 1923.

GROWTH OF THE IDEA

IN SUCCEEDING YEARS, Mr. Wickenden's reports contained recommendations for bringing together the educators, the profession, and the industry, in a coherent scheme of educational development. In 1927, speaking at the Annual Meeting of The American Society of Mechanical Engineers (ASME), he defined his concept in the following 10 points:

1. Act jointly; pool your interests with sister societies and colleges.
2. Take active measures to guide American youth in its consideration of careers.
3. Create a joint accrediting agency for colleges of engineering.
4. Re-examine and, if practicable, codify your rules of admission to membership.
5. Through student branches, educate students in the history, traditions, ethics, and social functions of the engineering profession.
6. Create joint sanctions for the award of professional degrees, and relate them to terms of admission to professional grades of membership.
7. Take a large share in directing the after-college education of young engineers.
8. Certificate the educational and professional attainments of engineers within the profession.
9. Take measures to create other credentials of educational attainment in addition to college degrees.
10. Do your part, through joint agencies, to promote the corporate welfare of engineering education.

The substance of these 10 points appeared later in the concept of ECPD.

IMPACT OF ASME

ANOTHER CHAIN OF EVENTS started at the 1927 ASME Annual Meeting. A question raised in the business session about the inequity of engineers' compensation compared to that of other professions led to the estab-

Condensed text of an address presented at a banquet commemorating the 25th Anniversary of ECPD, held during the EJC–ECPD Joint Assembly, New York, N. Y., Oct. 24-25, 1957.

C. E. Davies retired as Secretary of ASME on Dec. 2, 1957, after nearly 38 years on the ASME staff and 23 years as Secretary. He carried the administrative responsibility for, and was intimately associated with, the preliminary steps taken by ASME which resulted in the establishment of ECPD in 1932. He served as ECPD Secretary for its first two years.

lishment of a committee on the economic status of the engineer with Conrad N. Lauer as chairman, Wickenden was a member, as were Clarence F. Hirshfeld, Dexter S. Kimball, Harry Oatley, James M. Todd, W. A. Starrett, and Herbert L. Whittemore.

The resulting "1930 Survey of Earnings of Mechanical Engineers" was published in September 1931. Elliott Dunlap Smith of Yale University served as survey director, and Hudson Hastings, also of Yale, prepared the statistical tabulations.

The committee interpreted its task as broader than earnings, and included in its function "the suggesting of ways and means for broadening and deepening the engineer's life with a view to improving his status professionally and socially."

Accordingly, in October 1931, this committee and the ASME Committee on Registration recommended to the ASME Council a joint program for upbuilding engineering as a profession. The report was entitled "Certification into the Profession," and contained these five points:

1. Act jointly.
2. Take active measures to guide youth in its consideration of careers.
3. Co-operate actively in the educational process: Establish joint accredited agency for colleges of engineering.
4. Direct the after-college training.
5. Certificate the educational and professional attainments of engineers within the profession.

The October recommendations were approved by the ASME Council early in December 1931, and invitations were authorized to other societies to undertake joint action. From then on, events moved rapidly.

CONFERENCE ON CERTIFICATION

On February 3, 1932, the Conference on Certification into the Profession was convened by Mr. Lauer, then ASME President. Mr. Hirshfeld was selected as chairman, and C. E. Davies as secretary. The joint programs suggested by ASME was approved in principle. The National Council of State Boards of Engineering Examiners (NCSBEE) and American Institute of Chemical Engineers (AIChE) were invited to join the American Society of Civil Engineers (ASCE), the American Institute of Mining Engineers (AIME), ASME, AIEE, and SPEE, and a planning committee was appointed with General Robert I. Rees as chairman.

On April 14, 1932, with seven societies represented, the Conference adopted the report of the Planning Committee entitled, "The Development of the Engineer—A Program for Joint Action," and voted to establish the Engineers' Council for Professional Development to carry out the program.

A temporary organization of ECPD was formed by seven societies on October 3, 1932. Mr. Hirshfeld was selected interim chairman and C. E. Davies, interim secretary. The interim Executive Committee was made up of J. Vipond Davies, Donald F. Irvin, William E. Wickenden, Charles F. Scott, H. C. Parmelee, General Robert I. Rees, and D. B. Steinman, with the interim chairman and secretary. A Charter and Rules of Procedure were completed on March 13, 1933, and referred to the participating bodies for ratification.

Four standing committees were completely organized in May 1933. By the time of the first annual meeting, on October 10, 1933, six of the bodies had approved the Charter, and the seventh did so 10 days later.

The 1933 Charter was short. It described ECPD as a co-operative conference of bodies representing the professional, technical, and legislative phases of education and practice, and greater solidarity of the profession. Its immediate objective was the development of a system whereby the progress of the young engineer toward professional standing could be recognized by the public, the profession, and the man himself. The 4-point program included:

1. Means to assure entrance to the profession by young men who have the necessary aptitude and capacity.
2. Criteria for colleges of engineering to insure graduates a sound educational foundation.
3. Plans for the further development of graduates.
4. Methods of recognizing engineers who have met suitable standards.

The Charter further provided that ECPD would administer procedures approved by the boards of the participating societies, and stipulated that Charter changes require the approval of two thirds of the boards of the participating societies.

LEADERSHIP

The achievements of 25 years may be visualized in terms of the men who guided ECPD's progress. During the formative years, Mr. Hershfeld provided calm leadership, inspired by his conviction of the importance of ECPD as an influence on future generations of engineers. Robert L. Sackett, then dean of Pennsylvania State College (now University), chaired the Committee on Student Selection and Guidance for 10 years. He was succeeded by Allen Cullimore. Karl T. Compton gave the accrediting program its impetus, while S. C. Hollister, Thorndike Saville, and Harold Hazen gave devoted attention to the critical problems arising out of specialization in engineering education.

In later years, Harry Hammond laid the program for accrediting technical institutes.

Charles F. Scott—whose speech to the SPEE in 1922 sparked the first investigation—served three years as Chairman of ECPD, and for six years was chairman of the Recognition Committee. J. P. H. Perry, chairman for two years, brought the point of view of the practicing engineer to the work of ECPD. During Mr. Perry's term, the Engineering Institute of Canada became a member body. Robert E. Doherty was chairman for three years during World War II. Other chairmen whose vision and influence have sustained ECPD are

Everett S. Lee, James W. Parker, Harry S. Rogers, L. F. Grant, and Thorndike Saville.

SUMMARY

THE CHARTER OF ECPD today, not different in principle from the 1932 document, still incorporates the concept of a co-operative body with a unified program, much as stated by Wickenden in 1927 and in the 1931 plan for joint action. In 1951, the Charter was clarified, made more specific, and a provision added to the program encouraging co-operation between practitioners, educators, and students to maintain high educational standards.

In its 25 years on a minimum annual budget, ECPD has made important progress as a co-operative organization to administer the Wickenden ideal of a coherent unified program of continuous growth for the young engineer. The selection of entrants into engineering through the guidance program, stimulated by the present shortage, is being carried out on a national scale. The accreditation programs both for the bachelor's degree and the technical institutes are good, and the leaders of the programs are alert to the impact of present and future requirements. In post-college training, two conclusive demonstrations have established the soundness of the program which is now ready for country-wide extension. In the "Faith of the Engineer" and the "Canons of Ethics," ECPD has produced two splendid documents and is busy putting them to useful purpose. ECPD has represented U.S. engineering education in discussion with European educators with valuable results assured. ECPD took the lead in supporting a demand for a comprehensive study of the engineering profession.

CONCLUSION

THIRTY YEARS AGO Wickenden charged the organized profession to organize the novitiate of the young engineer into a much more orderly and effective process. That the attempt to round out a professional discipline by setting up ECPD was the answer was established by Dr. David B. Steinman when he reported to the National Council of State Boards of Engineering Examiners in 1932 with the following words: "The Plan of the Engineers' Council for Professional Development is the most constructive and forward-looking program that has ever been presented for advancing the status and recognition of our profession."

Magnetic Core Event Counter for Earth Satellite Memory

D. H. SCHAEFER
ASSOCIATE MEMBER AIEE

Micrometeorite bombardment of artificial earth satellites can be recorded through the use of counters. A description is given of the counter circuitry being developed to record this data.

ARTIFICIAL SATELLITES circling the earth are under bombardment by everything from cosmic rays to solar radiations to micrometeorites. Both atomic particle and micrometeorite hits can be recorded through the use of counters. The Lyman-alpha type United States satellites will be equipped with four microphones to sense micrometeorite impingements.

The counter outputs will appear in three channels of the telemetered signal presenting three decimal digits of the cumulated count. The frequency of the signals transmitted will be indicative of the count—the frequency, in one channel, representing the number of units; in another, the number of tens; and in a third, the number of hundreds. The total weight of the counter and its associated batteries for two weeks' continuous operation will be on the order of four ounces.

A block diagram of the equipment for the micrometeorite experiment is shown in Fig. 1. The pulse former takes the output of the transistor amplifier, which is a pulse of a few microseconds duration, and forms this into a very low impedance signal of constant

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The author wishes to acknowledge the contributions of P. Burris and J. H. Perry who performed the mechanical design and fabrication of the unit.

volt-second value of approximately one-tenth volt magnitude and one millisecond duration. This shaper consists of a magnetic core and transistors and can be described as the resetting circuit of the peak memory.[1] The constant volt–second signals are then fed into the unit stage of the counter. This counter accepts nine pulses from the pulse former, increasing the frequency

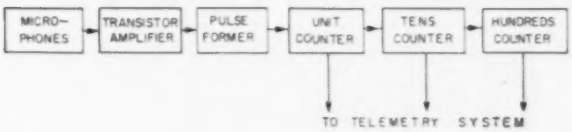

Fig. 1. Block diagram of micrometeorite experiment.

of its output oscillator upon application of each successive pulse. Upon receipt of the tenth pulse, the oscillator output frequency returns to its initial value and simultaneously a constant volt–second pulse is fed into the tens counter. The tens counter is practically an identical unit and on its tenth count it delivers a voltage pulse into the hundreds counter.

MAGNETIC MEMORY

THE BASIC ELEMENT of each counter is a square-loop nickel-iron magnetic core with a hole drilled in it, as shown in Fig. 2. This core with its hole has been termed a "cyclops." The core material is of a high remanence

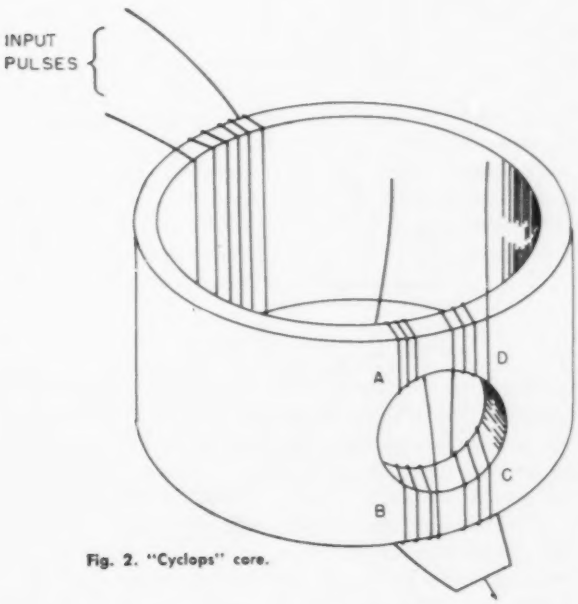

Fig. 2. "Cyclops" core.

or square-loop type of material. Such cores have the property of retaining their flux level even after the "setting" magnetomotive force has been removed. The purpose of the small hole and its associated windings is to provide a nondestructive read-out of the flux level.[1] When the windings in the small hole are wired as shown in Fig. 3, an oscillator is formed the oscillation frequency of which is a measure of the flux level of the core (Fig. 4). The curves indicated in Fig. 4 were made by first saturating the core in one direction and then applying constant volt–second pulses to drive the core to the opposite saturation. The three curves show frequency count for three different values of oscillator current, this current being adjusted by changes of the variable resistor (Fig. 3). It can be seen that the first pulse applied introduces a very large frequency change. The explanation for this is that this pulse drives the core firmly out of its saturated condition. The following

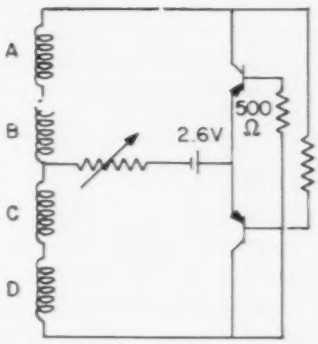

Fig. 3. Read-out oscillator circuit.

pulses pull the core further away from its initial saturation, the point of zero flux density appearing to be reached at about count 10. From there on, the flux level increases as the core proceeds toward saturation in the opposite direction. At count 28 and 29, signals existing in the circuit show that the knee of the hysteresis loop has been reached.

Fig. 4 shows that it is impossible to use the complete hysteresis loop of a "cylops" core for counter purposes. If the entire loop is traversed in a counting cycle, it is impossible to discriminate frequencywise between early counts and late ones. Furthermore, there is no frequency indication at all of increasing counts when the core is near zero flux level. These three curves also show that the most nearly linear region of the frequency vs count curve is the ascending portion of the curve. It is, therefore, necessary to set the core to a predetermined point on the ascending portion of the curve, and use the section of the curve between this point and saturation for counter purposes. It should be recalled that not only must a counter stage provide an unambiguous read-out of the count in the core, but also it must provide a voltage pulse to the following stage and reset itself upon receipt of the tenth pulse. The operating sequence of a decimal counter will be described in terms of the hysteresis loop shown (Fig. 5). Arbitrarily, assume the flux level to be at point *A*. Fixed volt–second input pulses change the flux level toward negative saturation in fixed increments as shown. Associated with each such input pulse is a voltage kickback upon termination of

each input pulse. Magnitude of this voltage kickback becomes greatly increased when pulses are applied after reaching the knee of the hysteresis loop, and this increased kickback voltage initiates operation of the reset circuitry to return the flux level to positive saturation. At positive saturation, the reset circuit is disabled and a voltage kickback at saturation provides an initiating signal to a preset circuit which returns the flux to point *A* to start a new counting sequence. Voltage appearing

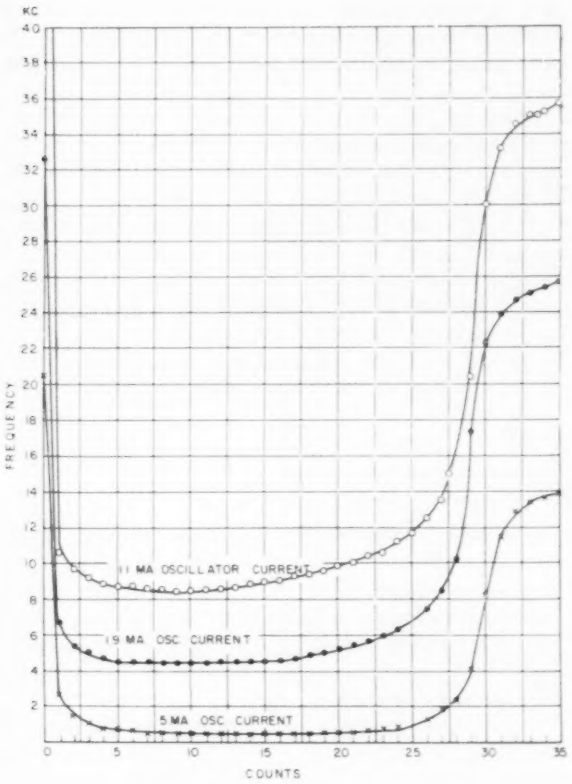

Fig. 4. Read-out oscillator frequency vs number of input voltage pulses for a "cyclops" core.

across an output winding during reset is used to advance the next stage one count. We will, therefore, first describe circuitry that will reset the core and provide a voltage pulse to a following stage. This will be followed by a description of preset circuitry needed to provide an unambiguous read-out.

COUNTING AND RESET CIRCUITRY

SQUARE LOOP CORES have previously been used in scaler applications.[2] The circuitry used to reset a core and simultaneously provide a voltage pulse to advance the next digit counter one count is shown in Fig. 6. To understand the operation of this circuitry, first assume the core to be at point *A* (Fig. 5). Pulses are injected into both base and collector circuits of transistor *A* (Fig. 6). The sense of the windings are so arranged that

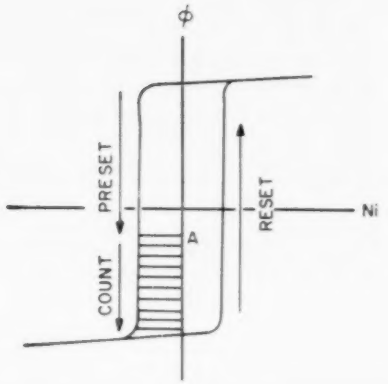

Fig. 5. Flux level sequence in magnetic counter.

each pulse will tend to drive the core toward negative saturation. The kickback produced when the voltage is removed by early pulses (when the core is in an unsaturated condition) is of a small value (Fig. 7a). As the core enters negative saturation, the magnitude of the kickback suddenly increases (Fig. 7b). The number of turns in the windings in the base circuit of transistor *B* and the bias voltage are so arranged that the large saturation kickback voltage of a count such as 7b will override the base bias battery of transistor *B* and put the

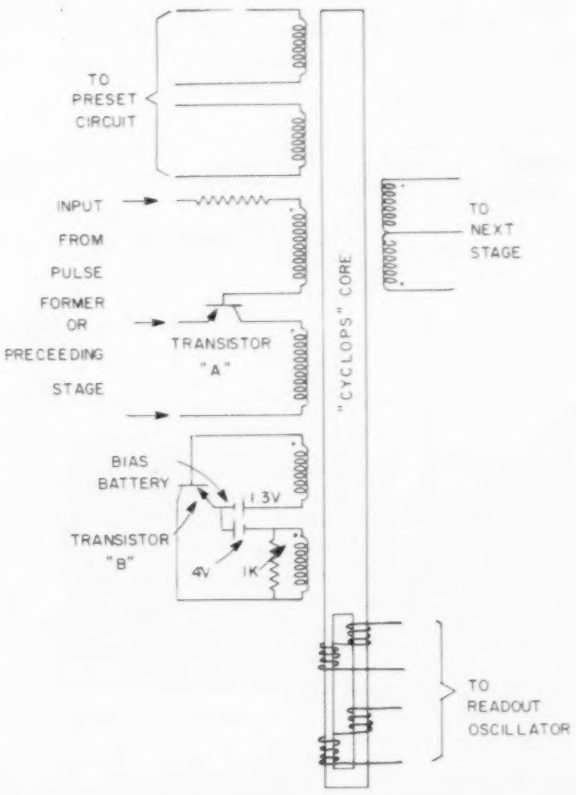

Fig. 6. Counting and reset circuits.

transistor into a conducting state. When this happens, the collector circuit battery voltage appears across the winding in the collector circuit. This voltage is, in turn, transformed to the base windings which puts the transistor even more fully into the conducting state and holds it in this state even after the initiating kickback voltage has disappeared. The battery voltage is applied to the core in such a polarity as to take the core from the negative saturation at which it just arrived back to

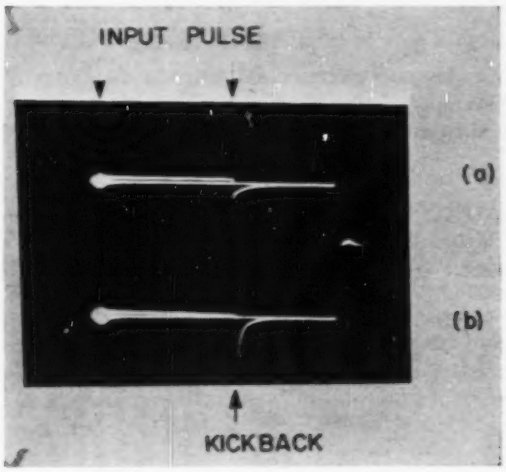

Fig. 7. (a) First input pulse and associated kickback. (b) Tenth input pulse and kickback.

positive saturation. The regenerative action set up will continue to hold transistor *B* in its conducting state until the core goes into positive saturation. As the core goes into saturation, the voltage across the base windings drops below that of the base bias battery sharply cutting off the battery voltage, and the core will be left at positive saturation. During the reset, the reset battery voltage is impressed across the windings. This reset voltage pulse is large compared to the incoming pulses of opposite polarity, and always contains a given number of volt-seconds. This pulse is, therefore, available as an input to the following stage. A reset pulse along with its initiating pulse is shown in Fig. 8.

PRESET CIRCUITRY

The reset circuit has left the core at positive saturation. It is now necessary to put a given amount of "preset" into the core before counting begins again, if unambiguous frequency indication of counts are to be available. The circuitry to be described allows a fixed current to preset the core to the proper flux level.

The trigger used to activate the current preset circuitry is the positive kickback generated when the reset voltage is cut off as the core enters positive saturation. As can be seen, the magnitude of this kickback (Fig. 8) is greater than the input pulses. The circuitry used to provide this current preset is shown in Fig. 9. The circuit is a complementary transistor monostable multivibrator.[1] Because of the amplitude discriminating ability of the silicon diode in series with winding *B*, only the large positive kickback voltage generated upon removal of the reset voltage is accepted as a trigger. This trigger signal applied to the base of the input transistor trips the multivibrator causing the output transistor to conduct. It is held in this state after the trigger signal disappears by the voltage across the tantalitic condenser. The output transistor is included primarily for decoupling purposes. Its action is to allow a fixed current to flow through core winding *A* (Fig. 9), for a time greater than a fifth of a second. With times in this order of magnitude, the duration of the pulse does not affect the amount of preset applied to the core—the current magnitude alone being the determining factor. Using this preset current, the portion of the curve between counts 20 and 29 (Fig. 4) is utilized. Fig. 10 is a plot of frequency vs counts for the system with voltage reset and current preset. Here, the oscillator is drawing 1.9 milliamperes current, and the frequency range is from 5 to 12.5 kc, which meets satellite requirements.

OSCILLATOR COMPENSATION

In the complete telemetering system, the read-out oscillators will be turned on by the telemetering commutator only when their signal is to be transmitted.[5] A single oscillator will be on, therefore, only a small fraction of the total time. The effect of the oscillator being in operation is negligible except when the preset current is actually being applied to the core. During this time, oscillator current will increase the amount of preset. This effect is appreciable and deprives the core of as many as four counts. A simple shunting circuit has been provided that decreases the amount of current flow when the read-out oscillator is on. Fig. 11 is a diagram of this shunting circuit.

TEMPERATURE COMPENSATION

The circuitry has been operated up to 50 C. The primary effect for which compensation must be made is a widening of the hysteresis loop with increasing tempera-

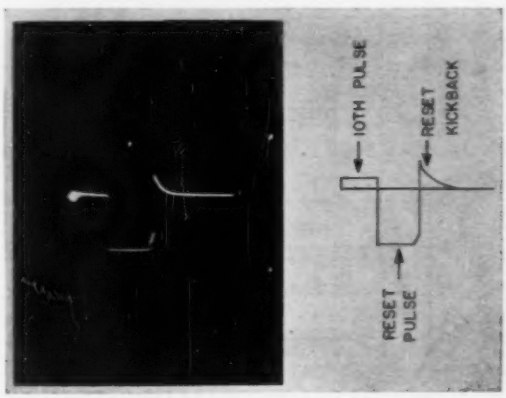

Fig. 8. Reset voltage pulse and its kickback.

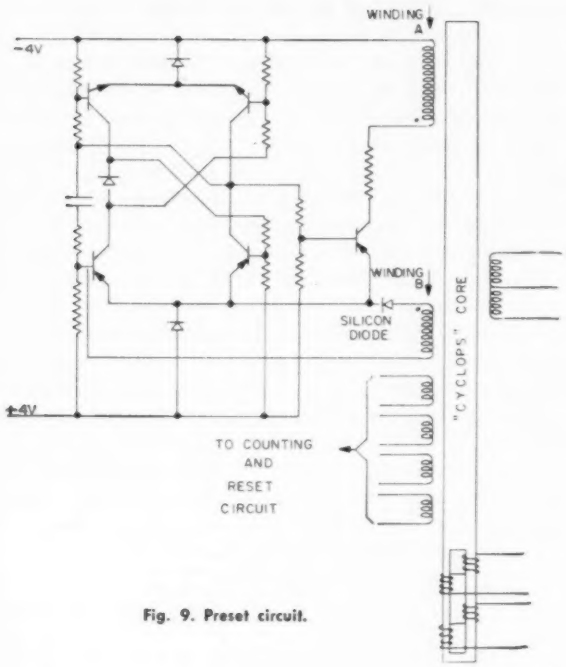

Fig. 9. Preset circuit.

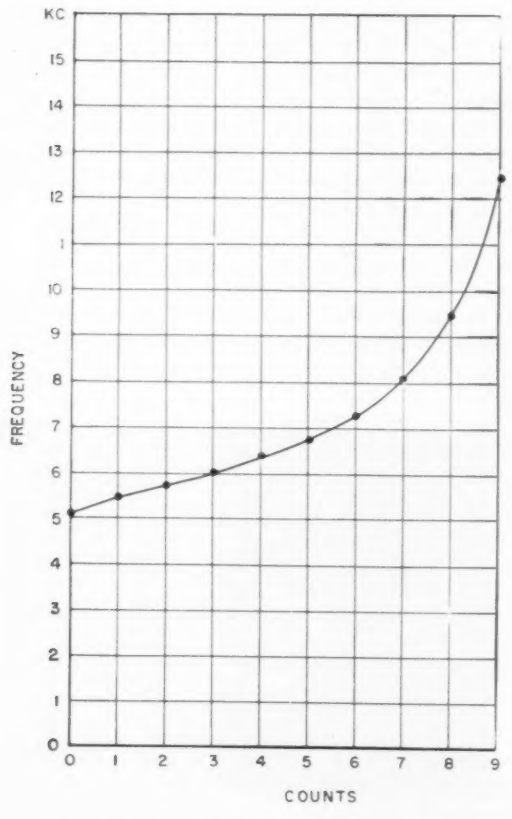

Fig. 10. Magnetic counter output frequencies.

ture. Because of this, the amount of current set must be increased as temperature increases. By replacing the resistors (Fig. 11) with thermistors, compensation can be provided so that the proper frequency range will be covered and every tenth count will reset the core. Temperature calibration must also be provided. Such a calibration is suitable for satellite use, as instrument compartment temperature will be available as a telemetered quantity.

CURRENT REQUIREMENTS

CONTINUOUS BATTERY DRAIN is on the order of one milliampere for the complete three decimal digit magnetic counter system. When the cores are actually accepting pulses, much greater current is drawn. The duty cycle for the larger drains is, however, negligible, being one millisecond of drain for each count.

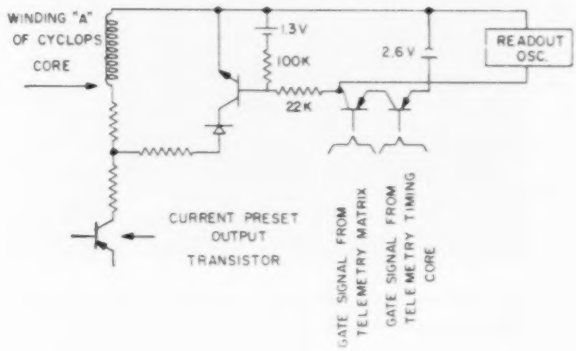

Fig. 11. Oscillator compensation circuit.

FLIGHT CIRCUITRY

THE COUNTER CIRCUITRY to be actually flown embodies the principles reported. In flight units, however, the preset circuitry of Fig. 9, along with the oscillator compensation circuit, is eliminated. Its functions are assumed by a circuit consisting of one square loop magnetic core and three transistors. The added core allows the cyclops to reset only to point *A* of Fig. 5. Its operation also places a tenth pulse on the cyclops core of larger magnitude than the preceding nine, insuring tenth pulse reset in spite of environmental changes of the cyclops core.

The equipment is capable of counting pulses arriving at rates in excess of 100 pulses per second.

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Economic Aspects of the Residential Heat Pump

C. W. BARY
FELLOW AIEE

AN "ALL-ELECTRIC HOME" cannot be attained without electricity providing comfort through heating and cooling. The economic attainment of this goal is feasible through development of the heat pump. This will be a different load, in its magnitude and characteristics, from the load electric utilities were acquiring in the past.

Costs per kilowatt-hour increase rapidly with a decrease in annual load factor. For example, if the cost per kilowatt-hour of the "demand" and "energy" components are 100% at a 45% diversified annual load factor, then they approximate 135% at a 30% load factor, 190% at a 20% load factor, and 690% at a 5% load factor.

Fig. 1 depicts the load characteristics of three types of heat pumps using outdoor air as a heat source or sink, for an average size home having a 55,000 Btu per hour heat loss, as well as the characteristics of cooling and of full use, the latter comprising lighting, miscellaneous small uses, and such major appliances as refrigerator, range, dryer, washing machine, and water heater, the latter operating under time control with a 17½-hour charging period. These characteristics apply to conditions of Philadelphia's metropolitan area.

The full-use home provides a 60% diversified annual load factor. For heat pumps operating with fixed home-thermostat settings, load factors vary from 23% for those with resistors to 33% for those with heat storage. But when they operate with night setback, load factors deteriorate to levels below 20%, except for the heat pump with heat storage which remains at 33%. The diversified annual load factor of cooling is less than 5%.

For illustration, it has been assumed that the 100% point of the aforementioned cost relationship is two cost units per kilowatt-hour, which relates to the average price of end-blocks of residential rates in cities over 500,000 population east of the Mississippi River; and further that it is compensatory for all additional uncontrolled residential electricity uses which provide a diversified annual load factor of 45%. Under these assumptions, the following relative costs per kilowatt-hour are obtained:

The lowest, at 2½ cost units, is for the heat pump with heat storage. It applies over the entire range of possible saturation, is independent of customers' practices in regard to home-thermostat settings days and nights. The highest, at 15 cost units, is for the cooling load alone beyond the relatively small saturation of this

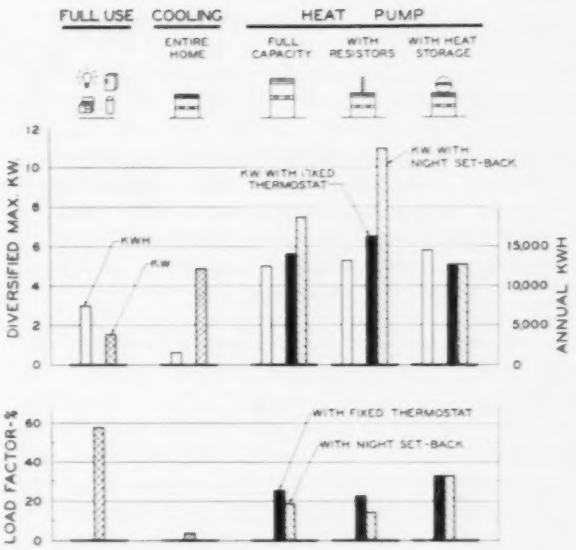

Fig. 1. Annual kilowatt-hour, kilowatt, and load factor.

application which exists only while it is filling up the summer valley of the residential load curve; the next to the highest, at 5 cost units, is for heat pumps with resistors when customers employ the practice of setting back the home thermostats for the night. Without the night setback, the cost for such a heat pump is 3¼ cost units.

With the possible wide variation in the cost to serve various heat pumps, and cooling and other loads in the home, new approaches, new methods, and new concepts are needed to solve successfully the economics of these loads. One solution lies in intensifying research and development on the heat pump to improve its performance factor and load factor; the latter is believed possible only through supplementary heat storage. Other solutions may be found in unconventional methods of electricity supply, such as through decentralized peak shaving with either diesel engines or gas turbines installed on the distribution systems; and in establishing unconventional "demand-energy" type rate structures for residential customers having more than a predetermined amount of use, wherein demands would be determined on a long time-interval basis to reflect automatically the relative effects of diversity in use of electricity in the home. This would provide an opportunity of making the cooling load carry its share of costs, thus enabling the heating load of the heat pump, especially with heat storage, to enjoy much lower increment rate than under the conventional "block-energy" type of rate structures.

Digest of paper 57-12, "Load and Economic Aspects of the Residential Heat Pump on Electric Utility Systems," recommended by the AIEE Domestic and Commercial Applications Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Winter General Meeting, New York, N. Y., Jan. 21-25, 1957. Published in AIEE *Applications and Industry*, May 1957, pp. 49-54.

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Objectives and Trends in Feedback Control Systems Progress

HAROLD CHESTNUT
MEMBER AIEE

Future progress in control systems design will include such activities as data processing, energy controlling, computation, and instrumentation. Control system reliability and higher quality production are also included as general objectives.

AT THE 1957 SUMMER GENERAL MEETING of the AIEE the Feedback Control Systems Committee sponsored a panel discussion on "Objectives and Trends in Feedback Control Systems Progress." Panel members included Prof. G. S. Brown, head, Department of Electrical Engineering, Massachusetts Institute of Technology; Prof. D. P. Eckman, Department of Mechanical Engineering, Case Institute of Technology; Dr. E. M. Grabbe, Computer Systems Division, The Ramo-Wooldridge Corp.; Dr. S. W. Herwold manager, Air Arm Division, Westinghouse Electric Co.; O. E. Orbom, manager, Electromechanisms Department, Allegheny Ludlum Steel Company; and Harry Palmer, manager of engineering, Specialty Control Department, General Electric Company (GE). Harold Chestnut, General Engineering Laboratory, GE, served as moderator. Although none of the panel members would admit to having a clear, crystal-ball picture of the future of this field, each was most willing to extrapolate into the years ahead based on his own personal experience.

The discussion revealed a number of significant trends. Foremost in this is the need for broadening the concept of feedback control to include a large number of activities such as data processing, energy controlling, computation, and instrumentation, all of which have a stake in feedback control but which at present tend to be segregated by the limits of the technical societies' structure. Ways must be found for discussing comprehensive control systems and for bringing about a common control language between peoples engaged in these different aspects of the common control problem. Trends toward more widespread use of digital controls and the inclusion of computers, both digital and analog, into controls were noted. Objectives of better quality production; i.e., higher performance and greater systems reliability to achieve reduced over-all costs were stressed. A better knowledge of the characteristics of the controlled system is being sought although it was felt that lack of complete knowledge of the system need not prevent important control objectives from being achieved.

SYSTEMS CONCEPT MUST BE BROADENED

DR. BROWN STARTED THE DISCUSSIONS by pointing out that the present concept of feedback control systems has expanded greatly from the simple position controls that were the concern of servomechanism and regulating system designers who joined forces in 1947 to form the AIEE Feedback Control Systems Committee. In order to solve the problems of stability and performance of these single closed loop controls, emphasis was placed on the use of mathematical models. Unfortunately, there has been a tendency for us to continue to concern ourselves with the mathematical model of the system. The trend in the future must be more in the direction of coming to grips with the new hardware that is available to control systems and with the broader concepts of control that are necessary. This trend then should be our guide as professional people who are in a position very near the heart of an applied technology that is so important to the success of the modern society in which we live.

Within the professional society, we have the opportunity to break through into new areas by recognizing that control is not the proprietary property of the electrical, the mechanical, the hydraulic, or the civil engineers, that the mathematical model is not the sacred cow, and that computation, data processing, and sensing or measuring are all an integrated professional activity. We need to adapt our minds to bring all this out into the open and to make this a very challenging and exciting adventure. We who are working with feedback control systems must find a way to open-end this activity so that we can come to grips with these more challenging systems problems that are not a respector of a specialized vocational area of activity.

As evidence of this trend toward a greater interdependence of the power and the control aspects of an industry, Dr. Brown cited a comment by a colleague of his to the effect that 20 years ago about 3% of the dollar cost of a machine tool was control equipment and this was comprised largely of an electric motor and a push-button. At the present time, about 30% of the dollar cost of the machine tool is often represented in control, and some companies are currently bidding on machine tools for the future in which an amount as high as 60 to 80% of the dollar cost of the entire product is control.

Harold Chestnut is chairman, AIEE Feedback Control Systems Committee, and is with the General Electric Company, Schenectady, New York.

Apparently industry in its organization and thinking is not adhering to the limited concept of feedback control systems. It is time that our technical society activity reflected the broader control systems concept. What we probably should do is reconstitute the Feedback Control Systems Committee as a new activity under the broad topic of Automata.

OBJECTIVES AND TRENDS

User's Viewpoint. Considering feedback control systems from the viewpoint of a representative of the heavy steel industry, Mr. Orbom of Allegheny Ludlum, stated that the objectives and trends of feedback control systems are dictated by very strong economic forces which require a better product at an acceptable cost. As costs mainly are influenced by wages and by productivity, productivity today is pretty much a matter of quality. Therefore, one of the end objectives of feedback control systems in a very practical sense must be better quality.

An important trend in achieving better quality is a concept worked out by several groups of a common language communication network such as by the medium of an IBM card, Remington Rand card, FLEXOWRITER, or some similar vehicle. This should permit a complete manufacturing process to be handled in a uniform fashion. It should permit one to perform automatically the necessary paper work that accompanies an order for a particular product. It should permit the automatic setup of the machine and should insert the necessary reference points to the controls. It should also produce a record of the production. This record, then, can be passed on to quality control personnel for evaluation and also to produce the necessary input cards to set up the necessary equipment to be used in the next stage of process. In other words, heavy industry believes that a very close alliance between the data handling systems and the machine control system is necessary for the success of better quality products. This intimate relationship between data handling and machine control strengthens the use of digital techniques. With digital data, compatible information is available for both purposes and is in a form that makes it usable in standard equipment.

The use of more comprehensive control systems is placing increasing emphasis on the need for improved transducers and sensors. New ways for determining online what is happening in a controlled process are urgently needed so that control action can be initiated to maintain within control tolerances the material being produced. The present way of using quality control after the fact to establish whether or not a product is acceptable is time consuming and expensive.

Systems work seems to be further along than the sensors. Along this line, the need for self-checking features within the control system is highly important. More and more, the position of the man in the control system loop is that of supplying the initial input and performing a monitoring and checking function in an over-all fashion. The control equipment should do a great deal of its own precise checking.

Reliability of control systems is of paramount concern to heavy industrial users. These users are not particularly concerned about the size or weight of the controllers as opposed to aircraft or missile control systems. Industry does not care whether equipment weighs a thousand pounds or a hundred pounds. All industry wants is to be sure that the reference points inserted in the equipment are reliable, that the fundamental measurements from the primary pickups are reliable, that the operation of the controlled system is reliable, and that the analysis of the problem is correct.

Military Equipment Supplier. One of the problems of the military, as indicated by Dr. Herwald, is that it is plagued by having too many people designing its systems and not enough people who know how to put hardware together. There seems to be a tendency for the military to get over-involved in the analysis of paper systems. We have got to get away from paper systems and get to real equipment that does the job. Somebody who understands the system has actually got to get down to the hard dirty work of making it operate properly. We must get away from the fellow who always has a system that works on paper but not one that ever works in fact.

In Dr. Herwald's opinion, the military applications have led the parade and, as far as he can see, will continue to lead the parade in the application of feedback theory. The military projects call for all the technical skills. It is hard to tell in a missile where the mechanical engineering starts and the electrical engineering leaves off or where the chemists or metallurgists take over. You generally have a good mixture of people with at least a broad enough background so that they do not resort to saying "It's out of my territory."

One of the biggest single things that is going on in the military program is the extension of the space coordinates in which feedback is being employed. We are trying to get information back over long and difficult lines of communications; for example, from missiles in flight hundreds and perhaps thousands of miles away. We would like to control where these missiles will fall. This is a feedback problem of a broad scope.

Complicating the situation is the fact that if one wants information over a much longer feedback loop, one also shortens the time available in which to get this information. This generates some real problems; as, for example, in a radar early warning network where high-speed targets must be detected, identified, and an appropriate action taken in a matter of minutes if not seconds.

Another thing that stands out from a military point of view is the problem of working with extremely noisy signals. Here again we fit into the digital data pattern because one can no longer sample data and decide by looking at it visually that this is good data and this is noise. It must be done statistically and it appears to Dr. Herwald that the best answer can be obtained by

solving the problem on a statistical digital basis. The thing, of course, that confuses the issue even further is that the enemy is always trying to make the data noisier via counter-measure techniques.

Another trend in the military is the general tendency to reduce the effect of the human operator anywhere inside the loop. Dr. Herwald would not go so far as to say we want to eliminate the human operator, but certainly the trend is to make the human operator a monitor rather than a man in the loop who has to do something. He is in a position where, if he does nothing, the operation proceeds automatically as planned.

A condition that is becoming critical is the paradox between the desire to perform more complex tasks in a tougher environment, but with a considerably greater degree of reliability, and a further reduction in size and weight. This, of course, results in the need for the improved components and technique that we are always talking about. Somebody has to make the hardware better, cheaper, and more reliable while someone else is making the system bigger and more complex. Only in this way will the increase in system complexity be tolerable from a cost and reliability point of view. Solid-state devices such as diodes, transistors and ferrites, and magnetic type devices such as magnetic amplifiers are being used effectively to help meet these needs.

The reliability problem goes hand in hand with the complexity problem. The average airframe of a few years ago used to have 5% control equipment whereas the average airframe of today has something above 50%. If one gets into the actual facts of per-unit reliability, we are so far ahead today that it is hard to believe the statistics. The problem is that we are getting complex faster than we are becoming more reliable. The techniques to find out where we stand reliabilitywise are very much sharpened in the military area. Almost everyone in it is really taking a scientific approach to the problem and beginning to come up with the significant things that affect reliability. This is just about where this discussion started because the kind of things that affect reliability do not turn out to be the big broad approach to the system. Rather, it is putting the filaments in the right place within a tube, not just putting them in. When one adds up all of the many little items such as this which are not designed with the utmost care, the system does not have the high reliability that was thought to be designed into it originally.

Last, but not least, in the area of military problems is the trend of going more and more toward automatic checking, both in the plant and in the field. As the equipment gets more complex, one just does not put in a voltmeter and say it reads 10 volts and therefore is okay. Some subtle checking must be done which gets into the area where one wants to program his check and to read and record his answer to it. This goes hand in hand also with what one is trying to do in the manufacture of the products. In the military, quantities are not huge and it is essential that the checking process be simply programmed and flexible. Ideally, the change in requirements should be capable of being handled merely by the replacement of one punched card or the like by another which can be simply and quickly prepared. This same progress of programmed instructions is one which lends itself to the original design and fabrication of parts, a trend which is under way but further in the future.

Control Systems Manufacturer. Mr. Palmer emphasized the point made by a number of the other speakers that feedback control of industrial systems basically is a systems problem. The control systems engineer, to do a satisfactory design job, therefore needs complete information on all of the components of this system even though he may have manufacturing responsibility for a very small part physically of its hardware. A control systems engineer must make sure that all the components used are compatible with each other. The use of some standard control components may require conception and invention of modifying equipment that negates all the advantages that originally were gained by using standard parts. In the power actuation portion of the control it is fairly easy to get the dynamic information required. However, it is very often difficult to get information on the transducers or feedback elements. These problems are not necessarily associated with the characteristics of the transducers themselves, but rather their characteristics as they are used in the system. This may involve transportation lags because they are measuring a function remote from the point of correction or because of the slowness of response of the process after corrections have been initiated.

Many times the fundamental problem is one of simply not having proper transducers because the instrumentation for control needs to be far more accurate than has previously been needed. In addition, there is a greater need for a transducer that measures the fundamental quality being controlled. Should we measure pressure, flow, and temperature or should we use a mass spectrometer or some such item to see whether our product is really right rather than try to determine its quality in an indirect fashion?

From the industrial control manufacturers' point of view it is extremely difficult to get data on the machine or process that he is controlling. Basically, there is a need for more fundamental type information than was needed ever before to build manual control. Knowledge of friction, backlash, wind-up, vibration, and resonances are all required to unite effectively the control and the machine. Many times it is necessary to change the philosophies of the process completely if one is to introduce automatic control. Mr. Palmer is sure that these will change as new requirements are pointed out and recognized by the industries involved.

The current trend is to design machines with the characteristics of the control in mind. Mechanical designers are now out in industry who have had training in control and are coming up with basic machine designs that are compatible with the needs and capabilities of control systems. There have been rather marked strides in this area by some machinery manufacturers

during the past year because of the fairly large armed services procurement program. This program has caused machinery manufacturers to face the problem of building a number of new machines to operate with automatic control. The firms that have had a chance to spend some time on the problem have made remarkable progress. For this reason, Mr. Palmer believes that these machines can be controlled as fast as even the hardened tools can cut metal. It is hoped that other industries will see and recognize the need of changing their practices in order to take full advantage of the economies possible with automatic control.

The one remaining thing is the matter of reliability. If any automatic control system is to be accepted by modern industry, it must be reliable. It has to be reliable with regard to the components used as well as the basic engineering approach. Component reliability must be evaluated very carefully. First, the safety factor provided under ideal environmental conditions must be very carefully considered. Second, the ability to perform under the environmental conditions imposed by industry must be factored in. The operation of a computer in a factory is certainly operating under different conditions from that in a business office. Reliability in each case is important, but the design requirements on the equipment will probably differ.

Process Control Viewpoint. Dr. Eckman stated that the objective of feedback controls systems for process control must be to help produce a product at an acceptable cost. The classical concept of a feedback control system consisting of a single variable being held to a fixed reference value or to some sort of path or command is of secondary and limited value to the process control engineer. Mainly, the problems of process control are to control a system to produce a product or more than one product and to do this in some reasonably economical or optimum manner.

Many years ago in process control, and even today to a considerable extent, the control problems were solved by a simple application of a number of individual controllers reading from variables at different points in the system, say as many as a thousand. Take such a system with a thousand independent variables, for example, and control each with a separate controller to hold all of these variables constant. Now, if the designers of this system had chosen the proper variables and the controls were applied properly, then, of course, the system is maintained in the steady state. Then, under that condition, it produces the products it was supposed to produce, provided the design is correct.

But this is not adequate, as time has proved, and the trend today is to give some consideration to dynamic design. Dynamic design is the problem of having a system with n degrees of freedom and of employing a control system which will control enough of those degrees of freedom to give an adequate product. This is not as easy as it might seem and is the problem that today's control engineer has yet to master.

The trend toward dynamic control has served to bring out into the open the real problem of process control; namely, to control a system knowing only a partial description of the system. If the system's behavior is known, including its commands, disturbances, loads, starting functions, and inherent transfer characteristics, then the work involved in establishing its performance is fairly well defined. However, with only part of this information available, the process control designer must come up with the best approximation to the system equation that he can make. Although a long-range objective in this area of process control is certainly to get increased knowldge of the dynamics of the processes being controlled, at present it is necessary to work with meager relationships.

To compensate for the lack of knowledge of the system's behavior, the use of computers is being tried in conjunction with the control. With computer control the best equation for the process and its control is assumed. The computer then predicts what should be done for the system to produce the desired end result and applies this computed value of behavior. Then, by sampling techniques during the operation of the system, the process behavior can be compared to the predicted behavior and the computer is then corrected for the control equation on the basis of the observed discrepancies. The method of sampling, computing, controlling, and correcting continues throughout the duration of the process control.

At Case Institute a specific process control was built and operated on the principle described. They were able to decrease the impurities of the produce from 10% down to a fraction of 1% which is the best the equipment can do anyway. In addition to improving the quality of the product, it is possible to assure that if the system is operating, it is operating at the maximum efficiency; i.e., the maximum yield per unit of time.

This is done by writing the equations for the conditions of an optimum control path and putting these equations into the computer. The information on the system performance is then put into the computer, which resets variables of the system and controls always to optimum behavior. In this way, at Case they were able to cut the time for a batch from approximately 4 hours to about 2½ hours. That is nearly halving the processing time or, in other words, doubling the productivity with the same piece of apparatus. This trend toward computer control has opened a great new era in the control of systems and in the control of processes.

There are considerable advantages to be gained in designing systems behavior to produce the kind of performance that is wanted. For example, recently there has been a great trend in chemical and petroleum processing to reduce storage and surge elements. In this way, a tank is eliminated that is used to store the product between one vessel and another vessel. This storage is used because it smooths out the random disturbance from a previous system or the specific variations from some previous operations and gives a smooth input to a following system. Enough confidence in control has been gained and enough system analysis has been performed

to eliminate storage in one refinery that would save over $1.5 million just in storage alone.

Another factor in process control that is important to feedback control engineers, is that in chemical processing only very infrequently will one know what the system is doing. That is, the exact description of the behavior of the system is not known. It can be obtained sometimes by analysis but often this fails because the system behavior cannot be described by equations that are linear or are under equilibrium thermodynamic situations. Therefore, analysis is very often inadequate. One can obtain the knowledge of the variables by correlation technique. Some very interesting work has been done in this area by Goodman and Reswick, and great steps are still possible here.

Another problem in process control is that the techniques of frequency response measurements (harmonic methods) are not always adequate. Processing systems are often so very slow that harmonic testing is expensive. Pulse techniques and system sampling need to be considered, studied, and thoroughly developed.

These then are the major trends in the field of process control. The consideration of: (1) system behavior with over-all multivariable problems predominant, (2) computer control for either static or dynamic problems, (3) redesign of processes to achieve better control, and (4) the determination of methods of obtaining and describing process behavior.

In addition, there are some minor trends that are noticeable, too. The first of these is toward the use of electronics in process control. This trend is not merely small or significant, it is almost explosive. The tremendous increase in analytical methods using electrical techniques, and in electronic transmitters and controllers, and in other electronic hardware is becoming very evident. The basic fact is that electronic controls at the present time are very closely associated in price with the cost of pneumatic controls and within a small percentage factor can actually meet the cost of this other method of control. It appears that there may be almost universal use of electronic controls in the future.

Next, the problems in process controls almost always involve nonlinear systems. Very often these systems are not just partially nonlinear, but they are essentially nonlinear. Chemical reactions are ones which involve the rate of change of a composition. This in turn is proportional to pressure to a power and also to an exponential power of the inverse temperature. Thus, the behavior of the system is essentially nonlinear and cannot be made linear by the usual series of other linearizing techniques. Much study needs to be put on the particular kinetic reactions and how they should be handled with feedback systems.

The last point Prof. Eckman made was the continuing trend in the direction of increasing use of analytical measurements rather than in the simple intensive variable measurements such as pressure and temperature. Analytical techniques of infra-red spectroscopy and chromatography, for example, have practically revolutionized many of the measurements in process control and permit the determination of the composition of substances to a high order of accuracy, even to very small fractions. The use of analytical means and sample data has taken a tremendous increase.

Digital Computer Viewpoint. Dr. Grabbe stated that the use of digital computers for process control holds the promise of increasing production, improving quality, and reducing cost by optimizing many present-day manufacturing processes. The typical plant of today uses automatic controllers involving feedback with an operator making adjustments. This is a major advancement over manual control. The next large step will be the application of the digital computer to assist the operator and provide completely automatic control. The use of computers is sure to change radically the design of future plants and provide spectacular results in production.

Although analog computers are being used in many industrial process control applications with beneficial results, digital computers have much more to offer for they represent tools of greater flexibility and versatility. They have been used effectively in military control systems. The digital computer has a high speed of computation, large storage capacity, stored program, and the ability to make decisions. All of these fit very nicely into automatic feedback control. Today, the operator stores in his memory and on charts certain rules for optimizing and operating a process based on design and operating experience. On the basis of these rules and experiences, he must make decisions in readjusting controls. With a computer in the control loops, the rules for operation not only are stored in the computer, but also may be corrected automatically for optimum control. Adjustments will be made in a consistent and reliable fashion, and fine details will be included to which the operator could not normally attend. Start-up, shutdown, and emergency actions can readily be handled.

We are on the threshold of industrial use of digital computers for control. It is necessary to demonstrate clearly their value in feedback control systems and to gain experience, because many benefits will accrue from practical usage. While there has been a great deal of talk and not much action, there are indications of major advances in the art, soon to come. Companies which a few years ago commented that computer control was fine—20 years from now, have assigned topnotch engineers to study the problem. Digital data logging equipment is available which does some computing. A number of experiments have been carried out on computer control. One of the most noteworthy of these was at Case Institute under the direction of Prof. Eckman.

The Ramo-Wooldridge Corporation has, over the last few years, carried out a number of systems studies directed toward the use of computers for industrial process control. These systems studies were aimed at understanding the dynamics of the process, determining control equations for optimizing control, finding suitable ways of measuring important process variables,

insuring that the resulting computer control system will be fail–safe, and evaluating the economics of computer control of the process. Such studies are not simple and are time-consuming. It is important to note that in order to establish control equations, not all of the details of the process need be known. If the approximate behavior can be described, the computer itself can be used to adjust the equation for optimum operation. Usually, both new instrumentation and some invention in designing a control system are also required.

As a result of the Ramo-Wooldridge studies a digital computer has been designed that will be applicable to a wide variety of industrial process control problems. This computer is now being constructed and will be announced in the near future. Dr. Grabbe described how they arrived at its characteristics:

1. The first decision was that a general-purpose machine was desirable inasmuch as this can best take over the job of the operator. It can be programmed for different processes and can easily shift from controlling one process to controlling another.

2. The storage capacity was set by studying typical problems in the process industry, such as cement manufacture and chemical and petroleum processing.

3. The speed of the computer was made high enough to meet present and future requirements. This is in anticipation of performing more functions than are presently required and speeding up operations.

4. The input and output were designed to accommodate a large number of input variable and output control signals, depending on the application. Instrument readings were converted to digital numbers. Provision is also made for manual input of information or typewriter print-out so that the computer can also be used as a data logger.

5. Last and of great importance—the computer will be highly reliable.

While present-day plants have not been designed for computer control, system studies show that many of them can employ digital computer control with considerable economic benefits. This is likely to be true for processes in which material inputs vary, a variety of products are produced, there are strong interactions between process variables, changes occur within the process such as catalyst deterioration, or when available control techniques do not provide stable control.

The computer must pay its way and should simplify plant operation—not complicate it. For initial installations, conventional instrumentation must be retained. Computer control is a revolutionary step and will require a thorough systems analysis for each application. Hence, systems engineering will become increasingly important and this may turn out to be the bottleneck in expanding the application of computer control systems.

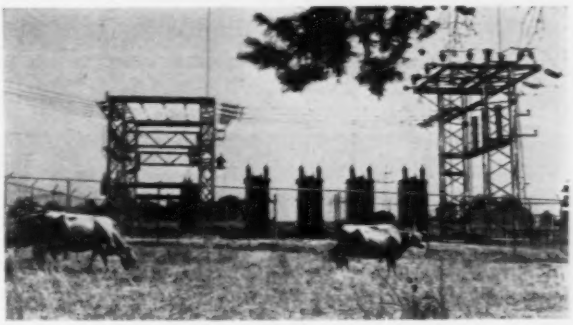
Gazing farther into the future, we can see the day when plants will be designed of such speed and complexity that they could not be controlled by present-day instrumentation and computer control would be necessary.

CONCLUSION

A STIMULATING DISCUSSION PERIOD followed the presentation by panel members. A number of new subjects were discussed and additional facets of the topics originally discussed were mentioned.

Throughout the discussion, there ran a strong central theme of a broadened control system concept involving the data processing, computing, control hardware, as well as the mathematical approach to control as being the major objective for feedback control systems progress. Control system reliability and higher quality production were other objectives mentioned for future progress in control systems design. Strong trends were noted in the direction of digital controls and controls involving highly nonlinear systems.

Signs of the Times



Despite the presence of a modern rural substation, these cows graze contentedly in a pasture near Cornelius, N.C. The 2,500-kva substation, owned by the Cornelius Electric Membership Corporation (CEMC), is equipped with four General Electric *RM* (repetitive manufacture) medium transformers. Each of the single-phase, liquid-filled, air-cooled units—one of which is available for emergency stand-by service—is rated at 833 kva. The Cornelius REC installed the new substation to meet the rapidly rising power demands of an expanding service area which now includes 2,700 electric meters. Like many other electric utilities and REC's, the Cornelius Electric Membership Corporation has turned to economical standard design transformers for the solution to expansion problems.

Coupling Methods for Power Line Carrier Systems

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POWER LINE carrier channels used for voice communication normally provide adequate performance. The use of carrier in telemetering, control and protective applications, however, increases the requirements for reliability and immunity to interference. Both these factors may be affected by the method used to couple the carrier signal to and from the power line. It is the purpose of this paper to compare line-to-ground and line-to-line coupling with respect to interference susceptibility and over-all channel attenuation.

It has been stated that line-to-line carrier transmission is less susceptible to interference than line-to-ground. A series of tests were carried out recently to compare the susceptibility of both coupling methods to three forms of interference. Fig. 1 shows simultaneous records of the effects of these three forms of interference on two receivers, one connected line-to-ground and the other line-to-line.

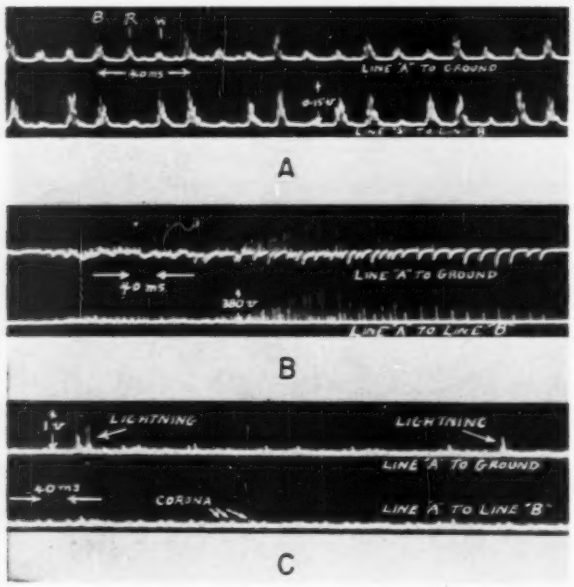

Fig. 1. Interference with line-to-line and line-to-ground carrier coupling: (A) corona noise; (B) disconnect switch noise; (C) lightning noise.

Fig. 1A shows noise due to corona. Peak noise voltages are about the same in both cases. The average value of the noise voltage, however, is 2 db greater in the line-to-line case. This is caused by the fact that the line-to-line connection picks up two corona bursts per cycle as compared to one burst per cycle with line-to-ground coupling.

Fig. 1B shows the effect of the operation of a disconnect switch about 200 feet from the carrier coupling capacitors. Noise peaks as great as 400 volts occur in spite of the intervening wave traps. This noise affects both systems equally.

Disturbances from lightning, shown in Fig. 1C, were recorded while a storm was in progress over the transmission line 20 miles away. On the average, the line-to-line connection picked up 6 db less noise than the line-to-ground.

Thus, significant reduction in noise pick-up with line-to-line coupling was observed only with respect to lightning discharges.

Chevallier has shown that a line-to-ground signal may be broken up into two components. The first is propagated between the coupling phase conductor and the other two conductors in parallel, and is attenuated at the same rate as a line-to-line coupled signal. The second is propagated between the three conductors in parallel and ground, and is attenuated about 10 times as rapidly. Thus, for a line longer than 50 miles, the second component may be neglected at the receiving terminal, and represents a fixed loss regardless of line length or frequency. Chevallier states typical values of 2.5 to 5 db for this additional line-to-ground attenuation. Taking into account additional coupling capacitor losses, line-to-line coupling, therefore, provides a decrease in overall attenuation of only about 1 to 3 db.

CONCLUSION

THE RESULTS of the interference tests show little advantage for line-to-line coupling except with respect to elimination of interference from lightning discharges. Lightning interference, however, is seldom a serious problem except where signal strengths are exceptionally low. The analysis of attenuation shows only a minor advantage for line-to-line coupling. Thus, considering only interference and attenuation, no great advantage for the more expensive line-to-line coupling is seen.

Interference to other carrier systems due to radiation from the line may be a problem where high power carrier transmitters are used. European practice favors line-to-line coupling in such cases to minimize radiation. Service reliability is also important. Single phase faults should produce less carrier attenuation with line-to-line coupling. These two factors require further study before a complete comparison of the two coupling methods can be made.

Digest of paper 57-1093, recommended by the AIEE Power System Communications Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Fall General Meeting, Chicago, Ill., Oct. 7-11, 1957. Scheduled for publication in AIEE *Power Apparatus & Systems*, 1957.
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Transformer Oil Preservation Methods

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IN ALL COMMONLY USED SYSTEMS of oil preservation for power transformers, the oil surface is exposed to a gas, either air as with a conservator system or nitrogen if the automatic-gas-seal system is used. Where a gas and a liquid are in such contact, some of the gas dissolves into the liquid, the quantity depending upon the kind of gas and liquid and their temperature and pressure. The solubility of nitrogen in transformer oil increases linearly with both pressure and temperature over the relatively narrow ranges encountered in transformer operation.

If a closed system of transformer oil blanketed by nitrogen is given time to reach equilibrium at an elevated pressure, and if the pressure is then released without the oil being disturbed, the nitrogen will remain in the oil, which is then said to be in a supersaturated state. If sufficient time is allowed, the overabundance of nitrogen will diffuse out of the oil in an orderly fashion until the system has restored itself to equilibrium corresponding to its new environment. If, however, the oil is pumped or similarly agitated while it is in an oversaturated state, the excess gas will emerge from the oil in a quite disorderly fashion; that is, by bubbling out.

In order to explore the probability of this phenomenon occurring under circumstances existing in some transformers in service, equipment with the following essential components were assembled: a tank containing heaters which represent a core and coil, a standard General Electric forced-oil forced-air unit cooler, standard automatic-gas-seal equipment, two sets of electrodes mounted under the oil in the tank, and miscellaneous devices for controlling, measuring, and recording the nitrogen content and temperature of the oil and the nitrogen pressure.

Several experimental runs were made with this equipment. Some simulated field operation of an automatic-gas-seal *FOA* transformer subjected to alternate loading and cooling and demonstrated how this cycling "pumps-up" the oil into a supercharged state which leads to bubble formation and loss of insulation strength. In one particular experimental run, three 24-hour cycles were used. Each cycle consisted of a period of 3 to 3½ hours during which the oil was heated from ambient temperature to 80 C followed by a 16- to 17-hour period during which the oil temperature was held constant at 80 C followed in turn by a 4-hour cooling period with the heaters off and the fans operating. The oil was pumped continuously. During the cool-down at the end of the third cycle, the gas pressure fell from 3½ psig to ½ psig and in this ½-hour interval, the oil went from 99% saturated to nearly 130% saturated. This caused heavy bubble formation in the oil and a marked decrease in dielectric strength, both impulse and 60-cycle.

Other runs simulating conservator operation were investigated. In these, the tank cover was vented exposing the oil to air at atmospheric pressure and the oil was temperature cycled and circulated until it became air saturated at 80 C. It was then cooled in the same manner as for the nitrogen cycles and comparable dielectric strength tests were made. No bubbles were generated and there was no loss of dielectric strength.

These experimental runs are probably reasonably faithful reproductions of conditions existing within transformers subjected to normal loading and ambient cycles followed by a period of light loading and rapid but not unrealistically rapid cooling. The physics of bubble formation is complex; nonetheless, these experiments have established that the oil in a forced-oil transformer can be expected to bubble and lose electric strength when its pressure differential reaches a value between 2 psi and 3 psi; that is, when it is oversaturated by 15% to 20%. In these tests, the nitrogen bubbles caused electric strength reductions ranging between 20% and 40%. These figures are representative but not necessarily typical. The authors have seen transformer oil lose more than ⅔ of its electric strength with gas bubbles. The extent of the strength loss is dependent upon the type of insulation structure, the condition of the oil and other factors which may be unpredictable at this time. The hazard of gas bubbles is considerably greater inside a transformer where the bubbles can collect beneath collars, inverted channels and other insulation pieces causing far greater loss of insulation strength than demonstrated in these tests. It is highly probable that these conditions have contributed to field failures in the past. These tests have demonstrated that:

1. Under certain service circumstances which cannot be considered abnormal, bubbles can form in transformer oil being preserved by a pressure-type system.
2. The gas bubbles thus formed reduce the electric strength of the oil and of the insulation structure of the transformer and increase field failure probability.
3. Where service conditions indicate that it is desirable to reduce the risk of failures of transformers now in service, the operating pressure can be reduced.
4. Unnecessary future risk can be minimized by the use of constant-pressure oil preservation systems such as the conservator type.

Digest of paper 57-1039, "The Effect of Transformer Oil Preservation Methods on the Dielectric Strength of Oil," recommended by the AIEE Transformers Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Fall General Meeting, Chicago, Ill., Oct. 7-11, 1957. Scheduled for publication in AIEE *Power Apparatus & Systems*, 1957.

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INSTITUTE ACTIVITIES

Dr. Kelly Launches Fund Drive for New United Engineering Center

PLANS for a new $10 million United Engineering Center to be erected on United Nations Plaza between 47th and 48th Streets in New York City, were announced Thursday evening, November 21, 1957.

The new building will serve as the headquarters of 16 National Engineering Societies with a total membership of about one quarter of a million engineers.

The new building will replace the present Engineering Societies Building at 29 W. 39th St. which is now inadequate in view of the tremendous growth of technology since the building was first occupied 50 years ago.

Announcement of the plans was made by Dr. M. J. Kelly, president of Bell Telephone Laboratories, who is serving as chairman of the industrial campaign to raise funds for the new Engineering Center. Dr. Kelly's announcement that commitments in excess of $1 million had already been secured featured the launching of the industry campaign at a dinner meeting at the Waldorf-Astoria attended by Hon. Herbert Hoover, honorary chairman of the campaign; A. P. Sloan, Jr., honorary vice-chairman; and more than 100 leading industrialists and educators from all parts of the country. Treasurer for the campaign is J. J. McCloy.

Present plans call for the occupancy of the building in the fall of 1960. It will be a 20-story tower surrounded by lower structures with landscaped grounds. The Center will not only have adequate facilities for present functions, but also will provide for continuing growth of the engineering profession.

The Engineering Societies Library will be included, and there will also be exhibition space in which the rapid advances in engineering will be interpreted for the general public. An engineering Hall of Fame to perpetuate the contributions of distinguished engineers to modern civilization is also under consideration. In all there will be about 250,000 square feet of floor space.

The industry campaign which Dr. Kelly heads has a goal of $5 million. Members of the various engineering societies are expected to contribute $3 million. This money, together with $2 million which is available in the assets of United Engineering Trustees, Inc., is expected to meet the $10 million cost of the new building.

Dr. Kelly also announced that nearly 150 presidents and deans of institutes of technology and engineering schools are supporting the campaign while more than 75 executives—presidents or board chairmen—of major industrial companies throughout the nation are serving as sponsors.

The Founder Societies whose headquarters will be in the new building are: AIEE; American Society of Civil Engineers; American Institute of Mining, Metallurgical, and Petroleum Engineers; The American Society of Mechanical Engineers; and American Institute of Chemical Engineers. Eleven associated societies will also have headquarters in the new building.

In announcing the start of the campaign, Dr. Kelly said, "Engineering Societies are repositories of the fundamental and applied technical knowledge of their fields and are agencies for its dissemination. Their meetings, publications, and committee activities crystallize thought on the technical problems of the engineering profession and insure that advances in technology become widely known, and available for general applications.

"They co-operate in establishing the necessary standards for our industry. They make large contributions to the professional status of engineering. Their numerous awards encourage invention and creativeness.

"The proposed United Engineering Center is a much needed facility for the Societies. Their operations are seriously handicapped by the inadequate space and obsolescence of their present headquarters at 29 W. 39th St., now more than 50 years old.

"Those of us associated in this campaign believe that the new center is a much needed facility and heartily recommend to industry their financial support of its construction."

Dr. Kelly also pointed out the tremendous growth in the Societies' activities during the past 30 years. The number of chapters throughout the country, for example, has grown from 258 to 684. Student chapters have grown from 220 to 605. Publications have grown from 407 to 1,640.

The associated societies who will have headquarters in the new building are: American Institute of Industrial Engineers, Inc.; American Rocket Society, Inc.; American Institute of Consulting Engineers; American Society of Refrigerating Engineers; American Water Works Association; Society of Naval Architects and Marine Engineers; Illuminating Engineering Society; American Society of Heating and Air-Conditioning Engineers, Inc.; The Electrochemical Society, Inc.; American Welding Society; and Society of Motion Picture and Television Engineers.

Also housed in the building will be Engineering Foundation, Welding Research Council, Engineering Index, Engineers' Council for Professional Development, and American Standards Association.

Architects for the new center are Shreve, Lamb & Harmon Associates. Engineers associated for the planning stage of the new center are Jaros, Baum and Bolles; for the structural stage: Seelye, Stevenson, Value and Knecht.

United Engineering Trustees, Inc., an organization set up by the Founder Societies to perform management functions on their joint behalf, will be in charge of the planning and construction of the building.

Members of the Campaign Executive Committee are: S. D. Bechtel, president, Bechtel Corporation; Albert Bradley, chairman of the board, General Motors Corporation; L. S. Cates, chairman of the board, Phelps Dodge Corporation; J. L. Collyer, chairman of the board, The B. F. Goodrich Company; R. J. Cordiner, president, General Electric Company; M. G. Dial, president, Union Carbide Corporation; E. G. Grace, honorary chairman, Bethlehem Steel Company, Inc.; H. T. Heald, president, The Ford Foundation; R. T. Hurley, president, Curtiss-Wright Corporation; J. R. Killian, Jr., president, Massachusetts Institute of Technology; D. C. McGraw, president, McGraw-Hill Publishing Company; Philip Sporn, president, American Gas & Electric Company.

Members of the Campaign Steering Committee are: R. E. Dougherty, Seelye, Stevenson, Value & Knecht; F. S. Friel, president, Albright & Friel, Inc.; E. R. Needles, Howard, Needles, Tammen & Bergendoff; C. S. Proctor, Moran, Proctor, Mueser & Rutledge; L. J. Sverdrup, president, Sverdrup & Parcel, Inc.; D. H. McLaughlin, president, Homestake Mining Company; Will Mitchell, Jr., associate director of research, Allis-Chalmers Manufacturing Company; L. F. Reinartz, consultant, Armco Steel Corporation; C. E. Reistle, Jr., executive vice-president, Humble Oil & Refining Company; H. De Witt Smith; W. B. Stephenson, president, The Allen-Sherman-Hoff Pump Co.; F. S. Blackall, Jr., president-treasurer, The Taft-Peirce Manufacturing Company; H. B. Maynard, president, H. B. Maynard and Company, Inc.; E. W. O'Brien, vice-president, W. R. C. Smith Publishing Company; E. J. Schwanhausser, vice-chairman, Worthington Corporation; J. C. Ward, Jr., president, Vitro Corporation of America; L. E. Cook, vice-president, Texas Power and Light Company; Bern Dibner, president, Burndy Corporation; R. G. Elliott, vice-president, Southern Bell Telephone and Telegraph Company; J. H. Foote, president, Commonwealth Associates, Inc.; K. A. Ganssle, assistant vice-president, Southwestern Bell Telephone Company; J. S. Noulton, vice-president and executive engineer, Pacific Gas & Electric Company; A. J. Frey, vice-president, Hoffman-LaRoche, Inc.; R. P. Genereaux, special assistant, E. I. du Pont de Nemours & Company, Inc.; J. J. Healy, Jr., director, development department, Monsanto Chemical Company; and C. F. Prutton, executive vice-president of the

Food Machinery and Chemical Corporation.

Distinguished scientists and engineers who have endorsed the campaign are: J. W. Barker, chairman of the board, Research Corporation; D. W. Bronk, president, National Academy of Sciences; Vannevar Bush, chairman of the Corporation, Massachusetts Institute of Technology; W. F. Gibbs, president, Gibbs & Cox, Inc.; K. T. Keller, past chairman of the board, Chrysler Corporation; F. H. Neely, chairman of the board, Rich's Inc.; Hon. D. A. Quarles, Deputy Secretary of Defense; J. R. Suman, consultant; E. R. Weidlein, past president, Mellon Institute; C. E. Williams, president, Battelle Memorial Institute.

Some 147 presidents and deans of institutes of technology and engineering schools have endorsed a statement supporting the campaign. Among them are: Dr. E. S. Burdell, president, The Cooper Union; Dr. James Creese, president, Drexel Institute of Technology; Dr. J. H. Davis, president, Stevens Institute of Technology; Dr. L. A. DuBridge, president, California Institute of Technology; Dr. T. Keith Glennan, president, Case Institute of Technology; Dr. L. W. Houston, president, Rensselaer Polytechnic Institute; Dr. F. L. Hovde, president, Purdue University; Dr. J. R. Killian, Jr., president, Massachusetts Institute of Technology; Dr. J. T. Rettaliata, president, Illinois Institute of Technology; Dr. Ernst Weber, acting president, Polytechnic Institute of Brooklyn; Dr. M. D. Whitaker, president, Lehigh University; R. W. Van Houten, president, Newark College of Engineering; Dr. J. C. Warner, president, Carnegie Institute of Technology.

Photographed by Will Weissberg

THE NEW ENGINEERING CENTER to be erected on United Nations Plaza between 47th and 48th Streets, New York City, is demonstrated by Dr. M. J. Kelly (left), chairman of the industry campaign to raise funds for the new building, to AIEE President W. J. Barrett, who is president of United Engineering Trustees, Inc., builders and operators of the new headquarters for the engineering profession in the United States.

Largest Technical Program Scheduled for 1958 AIEE Winter General Meeting

THE AIEE Winter General Meeting, to be held at the Hotel Statler (meeting headquarters) and the Hotel Sheraton-McAlpin, New York, N. Y., February 2-7, 1958, will feature the largest technical program in the history of the Institute. The social activities, for which the Winter General Meeting is well known, will again be outstanding. A group of varied and interesting inspection trips has been arranged closely allied with the technical sessions.

General Session

The featured speaker at the general session on Monday afternoon, February 3, will be T. J. Watson, Jr., chairman of the board of directors, International Business Machines Corporation (IBM). During this session, the Edison Medal will be awarded to J. K. Hodnette, vice-president and general manager, Westinghouse Electric Corporation. The AIEE Prize Paper Awards also will be presented at this time. President W. J. Barrett will open the session with his report to the members of the Institute.

Technical Sessions

Following is a description of one of the many interesting technical sessions which will be held during the Winter General Meeting.

AIEE has invited top speakers to discuss the relationship between the new field of information processing and electrical engineering during a Research session on Information Processing entitled "Thinking Machines of the Future," Thursday afternoon, February 6.

With a full-blown computer industry, rapid strides in automation, and new developments in communication, there must be an entire accompanying field of research and development covering the nature of information and its efficient expression and handling.

Electrical engineers more than ever are conscious of a need for research and development in information processing, in addition to research on computer circuitry and equipment, and application of computers to power and other industrial processes. The purpose of the session is to promote thinking in the area of information processing and to stimulate research paralleling existing research on materials and techniques related to information processing and communication.

In the proposed session, three prominent scientists will explore the basic concept of information itself as well as the use of computers for conveying, digesting, and processing information to optimize various controlled processes, or bypass various human operations between the concept and production stages.

The session will be addressed by Dr. J. B. Wiesner, Massachusetts Institute of Technology; Dr. Simon Ramo, Ramo-Wooldridge Corporation; and Dr. C. R. DeCarlo, IBM. Dr. Wiesner's presentation will bring to members the viewpoint of the college laboratory in which fundamental mental processes are being explored in order to determine the feasibility of applying these processes to computers. Dr. Ramo represents the large research establishment concerned with vital transmission and processing of complex masses of information, and Dr. DeCarlo speaks for the computer manufacturer who takes a broad look at the entire field of man's information-processing requirements to determine logically delineated categories of requirements which can be handled by specific lines of equipment.

The session is sponsored jointly by the Research Committee, the Computing Devices Committee, the Communication Theory Committee, and the Data Communication Committee. The session should be of great interest to computer manufacturers, educators, those interested in communications theory or data transmission, and generally to all concerned

Membership in the American Institute of Electrical Engineers, including a subscription to this publication, is open to most electrical engineers. Complete information as to the membership grades, qualifications, and fees may be obtained from Mr. N. S. Hibshman, Secretary, 33 West 39th Street, New York 18, N. Y.

with the advanced development of information processing and transmission.

Informal Tea

This social gathering before the formal program begins has been enjoyed by more and more people each year. Make it a point to attend this year—Sunday afternoon, February 2, from 4 to 6 p.m., in the Georgian Room of the Statler. There will be no charge.

During this period, the registration facilities will be open for those wishing to avoid the Monday morning rush.

Hotel Reservations

Blocks of rooms have been set aside at the Statler and nearby hotels for members and guests attending the meeting. Members should send requests for reservations to the hotel of their choice, specifically referring to the AIEE meeting in their letter. Please do not write to more than one hotel. If requests cannot be filled, the hotel will automatically refer requests to the Hotel Accommodations Committee whose duty it is to obtain a similar reservation at another of the convention hotels. The hotel will confirm directly to the member. No guarantee that members will be housed satisfactorily can be made if requests are received after January 13, 1958.

Because of the crowded condition in New York hotels, it is suggested that reservations be made for arrival on Sunday, February 2, 1958, thereby avoiding delays in registration or unavailability of rooms in the early morning of subsequent days. It is also suggested that a request for reservations prior to Christmas is more likely to be filled.

Rooms have been allotted for AIEE use by the following hotels at the daily rates indicated:

Hotel Statler (Meeting headquarters), 7th Ave., 32nd to 33rd St.

Single Room	$ 8.00 to $14.00
Double Room	11.00 to 18.00
Twin Bedroom	15.00 to 22.00
Suites	36.00 to 37.00

Hotel Sheraton-McAlpin (also used for meetings), Broadway and 34th St.

Single Room	$ 6.85 to $14.85
Double Room	10.35 to 17.85
Twin Bedroom	13.35 to 18.85
Suites	25.00 to 32.00

Hotel New Yorker, 8th Ave. at 34th St.

Single Room	$ 8.00 to $13.00
Double Room	11.50 to 16.50
Twin Bedroom	14.50 to 19.50
Suites	24.00 & up

Hotel Martinique, Broadway and 32nd St.

Single Room	$ 6.50 to $11.00
Double Room	9.50 to 14.50
Twin Bedroom	9.50 to 14.50

Hotel Commodore, Lexington Ave. and 42nd St.

Single Room	$ 7.00 to $14.00
Double Room	12.00 to 17.00
Twin Bedroom	12.00 to 18.00

Hotel Roosevelt, Madison Ave. and 45th St.

Single Room	$10.50 to $13.50
Double Room	16.00 to 19.00
Twin Bedroom	18.50 to 21.50

All rooms have private bath and the rates quoted are subject to a 5% New York City hotel room tax.

Smoker

A highlight of the Winter General Meeting will be the Smoker to be held Tuesday evening, February 4, 1958. Good food, good fellowship, and top quality entertainment will be the feature of this event which will take place in the Hotel Statler.

Attendance will be limited for the comfort of guests. Ticket requests should be mailed at an early date. The price will be $11 per ticket and requests should be addressed to "AIEE Smoker Committee," 33 West 39 St., New York 18, N. Y., accompanied by checks made payable to "Special Account, Secretary, AIEE."

Dinner-Dance

A Dinner-Dance will be held Thursday evening, February 6, in the Grand Ballroom of the Hotel Statler. General arrangements will be the same as those which proved enjoyable last year. Dress will be formal. Write soon for reservations. Tables seat 10. The price this year is $12.50 per ticket and requests should be sent to "AIEE Dinner-Dance Committee" at 33 West 39 St., New York 18, N.Y., accompanied by checks made payable to "Special Account, Secretary, AIEE."

Inspection Trips

A program of inspection trips of both technical and general interest has been arranged for those attending the Winter General Meeting. Because the number of persons who may be accommodated on each of these trips is limited, members who are interested are urged to make arrangements and obtain full details at the Inspection Trips Desk immediately after registering.

On some of the trips, proof of U. S. citizenship will be required, and members should be prepared to comply with such security regulations as may be in force at the time of the trip.

Radio City Music Hall, New York, N.Y. (Tuesday morning). This ever-popular trip has been scheduled again. Spectacular stage shows distinguished by unique lighting effects have made the Radio City Music Hall an outstanding attraction for visitors from all over the world. Members will see the backstage facilities as well as unusual features, such as the revolving sectionalized stage, elevating orchestra pit, motorized curtains and the multitude of electric and mechanical controls required for the special stage and lighting effects.

East River Generating Station, Consolidated Edison Company of New York, Inc., New York, N.Y. (Tuesday morning and afternoon). The East River Station of the Consolidated Edison Company is located at East 14th St. and East River Drive. Arrangements for the trip will include a short bus ride from the Statler Hotel to the generating station.

This will be a guided tour of New York City's second largest generating station located adjacent to a modern residential center which imposes stringent requirements on noise and smoke abatement. Since 1951, four 60-cycle units have been placed in service, each one is rated at 150,000 kw or more. The tour will highlight these new units and their associated boilers and auxiliaries as well as the newest in 69-kv and 138-kv transformers, metal-clad bus and switchgear.

New Ticket Bureau, Pennsylvania Station, New York, N.Y. (Tuesday, Wednesday, and Thursday, several tours throughout day). The Pennsylvania Railroad's new Ticket Sales and Service Bureau combines a startling variety of electronic and mechanical devices designed to help make reservations, sell and deliver tickets, and give information more efficiently and more quickly than ever before attempted. An assembly of some 500 communication devices, including closed-circuit television systems, facsimile machines, longhand-writing reproducers, and other more conventional apparatus, has been arranged to provide fast and error-free handling of space reservations, ticket sales, and allied services in connection with railroad passenger travel. The equipment provides means for facilitating these services not only over the counter at the main ticket bureau but also at nine outlying branch offices, including Newark and Trenton, N.J.; at a number of subscribers to a facsimile connecting system; and to those who wish to make preliminary arrangements by telephone. The workings of the system must be seen to be believed.

International Business Machines Corporation, New York, N.Y. (Tuesday morning, Wednesday, and Thursday afternoons). IBM is planning to conduct a program consisting of a discussion of medium- and large-scale computers. Following this will be a tour of the data processing center covering the type *705* Electronic Data Processing Machine and a demonstration of the *305* RAMAC.

Ford Motor Company, Mahwah, N.J. (Tuesday afternoon). This tour of one of the largest auto and truck assembly plants in the world offers an excellent opportunity to see all the interesting work that goes into the assembly of an automobile. On 1,714,050 square feet of manufacturing space, 45 freight carloads of auto parts are converted daily, using 10 miles of conveyor lines and a 1,025 foot final car-assembly line, into completed cars and trucks. The plant is capable of turning out 1,216 cars and trucks when operating on a 2-shift, 16-hour day.

Bell Telephone Laboratories, Murray Hill, N.J. (Tuesday afternoon). Assembly will be in the Arnold Auditorium at 2 p.m. A. R. Brooks, publication manager for New Jersey Bell Labs, will speak, describing the Laboratories, its place in the Bell System, and its method of operation. Following this, a description of recent developments in solid-state electronics will be given.

Groups will visit a cross-section of different laboratories, to give a broad picture of the scope and fields of science that are studied at Murray Hill.

Aliens are not excluded but must indicate their status on their reservations. Bus leaves Statler 12:45 p.m., returns 5:15 p.m. Reservations $2.

Federal Pacific Electric Company, Newark, N.J. (Tuesday afternoon). This trip will consist of a general inspection of Federal Pacific's extensive facilities for the

production of Stab-lok circuit breakers, AB and AB-I circuit breakers, and industrial motor control. Visitors will tour the plastics molding and small parts departments, the quality control stations, powdered metallurgy facilities, and assembly departments. Guides will explain the various subassembly operations, calibration, and inspection, and other general manufacturing procedures. The plant, covering 156,000 square feet, produces circuit breakers at the approximate rate of 10 million per year.

Sikorsky Aircraft, Division of United Aircraft Corp., Stratford, Conn. (Wednesday all day trip). Sikorsky's new Stratford Plant, opened in 1955, covers 830,000 square feet of floor space, plus surrounding acreage for flight line and air operations. A 500,000 square foot engineering and research addition which is scheduled for completion in 1958 is now in construction.

Located just north of Stratford (northeast of Bridgeport), the plant is adjacent to the Housatonic River crossing of the Merritt Parkway.

The inspection tour will cover all unrestricted manufacturing facilities here, including subassembly and main assembly of one of the world's largest production helicopters. Completed units will be available for inspection and, weather permitting, actual flight test operations will be witnessed.

Citizenship required, no cameras allowed.

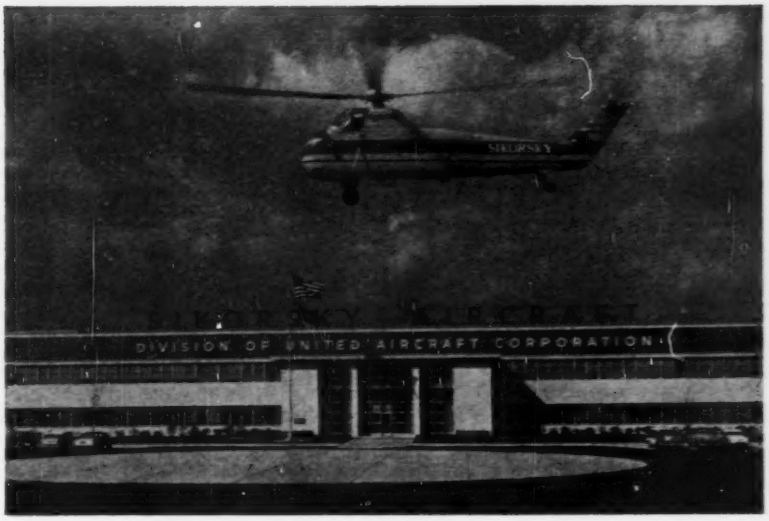
Bethlehem Steel Company, Shipbuilding Division, Hoboken Yard, N.J. (Wednesday morning). The Hoboken Yard, advantageously situated on the New Jersey side close to the North River Piers, is one of the largest and most modern and efficient repair yards in the nation. With a 1,500-foot river frontage and an area of close to 40 acres, it can handle 16 to 20 average-sized vessels at the same time within the confines of the yard and an even greater number at outside piers and anchorages.

Expanded and renovated through a long-range program, this yard has an unusually complete range of modern shops and facilities. The machine shop is equipped with several hundred machine tools including a double-end lathe with a 50-inch swing and 54 feet between centers, and a planer with a 9- by 31-foot table and a 54-foot bed length. The yard has available four drydocks of the floating type with two of them having lifting capacities of 20,000 tons each.

The tour will permit a thorough view of yard facilities including piers and drydocks and encompassing a trip through the newest and most modern shore-based oil-tank cleaning facilities in the country and through the machine shop.

Only United States male citizens are permitted.

Reaction Motors, Denville, N.J. (Wednesday afternoon). Reaction Motors manufacture rocket engines and their controls. The tour will be a two-hour inspection of their test facilities including a static test stand which is the largest in the East and their underground observation facilities and instrumentation. A missile type rocket will be set up in the test stand at the time of the tour.



AN ALL DAY INSPECTION TRIP to Sikorsky Aircraft, Division of United Aircraft Corporation, Stratford, Conn., will take place Wednesday, February 5, during the 1958 Winter General Meeting of the AIEE. The inspection tour will cover all unrestricted manufacturing facilities.

Bus leaves Statler 12:30 p.m. Reservation $1.75.

Westinghouse Lamp Works, Bloomfield, N.J. (Wednesday afternoon). This is the largest manufacturing facility for the production of mercury lamps and special incandescent lamps. Visitors will be able to see development activities of Westinghouse Lamp Engineering Laboratories as well as the extensive assembly line manufacturing setup. Also on display are the latest laboratory models of new sources of panelescent lighting and research department samples of lamp products for the future.

Edward F. Barrett Power Station, Long Island Lighting Co., Island Park, L.I., N.Y. (Wednesday afternoon). The 128-acre site of reclaimed marshland now houses one of an ultimate of six generating units. The guided tour features 185,000-kw generator, single boiler, tandem compound turbine. The outdoor turbine and semioutdoor boiler are unusual in this latitude. Rail coal delivery facilities, unified control center and the 310,000-kva, 138-69-33-kv substation also will be shown as part of the tour.

Brookhaven National Laboratory, Upton, N.Y. (Thursday morning). The facilities of this location are operated by Associated Universities, Inc., under contract with the Atomic Energy Commission, and constitute the Northeastern Center for Nuclear Research and Development in the fields of physics, chemistry, isology, medicine, and engineering. Among the important exhibits which members will see are the atomic pile, "hot" laboratory, and the Cosmotron. A complete tour has been arranged and competent guides, engineers, and scientists will be on hand to explain fully the extensive facilities and exhibits which have been erected at this vast site. United States citizens only.

Bus leaves Statler 8:00 a.m., returns 5:30 p.m. Reservation $5.25, includes bus fare and lunch.

Linden Generating Station, Linden, N.J. (Thursday morning and afternoon). Public Service Electric and Gas Company's new Linden Generating Station is one of the company's chain of eight generating stations now in service or under construction. This station, which has an initial capacity of 450,000 kw in its two units, is unique in its extremely high efficiency which can only be obtained by utilizing the heat in the steam in industrial processes following its passage through the turbines. The steam, up to a maximum of 1,550,000 pounds per hour, is supplied to the Bayway Refinery of Esso Standard Oil Company, which adjoins the new station. In return for the steam, Esso furnishes fuel oil and water.

In the past, the price of higher economy has been higher steam conditions and the added complications of such features as reheat, pressurized furnaces, and gas recirculation. At Linden, the price of the high economy lies in the additional complications of automatic steam extraction from the turbines, a water treating plant for high make-up, the special features for handling and burning high viscosity fuel, and the provisions to assure reliability of steam supply.

The auxiliary power supply for the station is unusual in that the boiler auxiliaries of each unit always have two sources of electric supply, whether or not the associated turbine–generator is in service.

Western Electric Company, Kearney, N.J. (All day trip). This is one of the largest manufacturing plants of this supply organization for the Bell System. Included in this tour will be the multiconductor cable shop, relay blade manufacturing, and assembly of manual and automatic switchboard equipment.

Only United States citizens are permitted. No cameras.

Phelps Dodge Copper Products Corp., Habirshaw Cable and Wire Division,

Bimonthly Publications

The bimonthly publications, *Communication and Electronics, Applications and Industry,* and *Power Apparatus and Systems,* contain the formally reviewed and approved numbered papers presented at General and District meetings and conferences. The publications are on an annual subscription basis. In consideration of payment of dues, members (exclusive of Student members) may receive one of the three publications; additional publications are offered to members at an annual subscription price of $2.50 each. Nonmembers may subscribe on an advance annual subscription basis of $5.00 each (plus 50 cents for foreign postage payable in advance in New York exchange). Single copies, when available, are $1.00 each. Discounts are allowed to libraries, publishers, and subscription agencies.

Yonkers, N.Y. (Thursday afternoon). Included will be tours of the Nepperhan plants where telephone cable and rubber and plastic insulated wire are manufactured, followed by a tour of the Glenwood plant where high-voltage cables are produced. The Glenwood plant includes facilities for applying aluminum sheath to power and communications cable. The tour will be completed in the Research Laboratories which house a two million volt impulse generator.

Ladies and cameras are not permitted.

Holophane Light and Vision Institute, New York, N.Y. (Thursday afternoon). This lighting clinic is a unique permanent demonstration of lighting principles where there are ingenious mechanical displays of how the eye sees, how it can be deceived, how lighting levels are determined, and how colors should be chosen. Visitors will be able to see the effect of shadow diffusion and contrast on various visual tasks in specially constructed movable devices. Of special note are the small demonstrations of light-controlled devices that visitors are able to operate for themselves. Refreshments will be served at the conclusion of the meeting at the Holophane executive offices.

Theater Tickets

No tickets to theaters will be sold at the meeting, but they will be available through an agency. Leblang's Theatre Ticket Agency has set aside blocks of tickets to be distributed on a first-come first-served basis, preferably through mail orders.

Tickets to the following shows currently playing in New York will be available to AIEE members during the week of the meeting. All prices shown are brokers' prices.

	Evenings M,T,W,T	Evenings F,S	Matinees W
Bells are Ringing Judy Holliday, musical	$9.43	$9.43	$5.98
Compulsion psychological drama	7.13	7.98	Mats. only on weekend
Fair Game Sam Levene	7.13	7.13	5.98
Li'l Abner comic strip musical	9.43	9.43	6.18
Long Day's Journey into Night Frederic March	8.28	8.28	No mats.
Look Back In Anger London drama	7.13	7.13	5.68
Nude with Violin Noel Coward	7.13	7.98	5.98*
New Girl in Town Gwen Verdon, musical	9.43	9.43	5.98
Romanoff and Juliet Peter Ustinoff	7.13	7.13	5.48
The Cave Dwellers Saroyan comedy	7.13	7.63	6.23

*Thursday matinee.

Orders for the listed theater tickets should be sent directly to: Leblang's Theater Ticket Agency, 224 West 47th St., New York, N.Y., Attn: Mrs. Dorothy Zeikel. Checks covering the entire amount of the order must be included, and should be made out to Leblang's Theater Ticket Agency.

All tickets will be left at the theater box office in the name of the purchaser, together with any refunds required.

Ladies Entertainment

A full and varied program is planned for the ladies accompanying their husbands to the Winter General Meeting. The Washington Room at the Statler will again be Ladies' Headquarters for registrations, get-togethers, and a long morning Coffee Hour. Registrations will begin on Sunday from 2 p.m. to 4 p.m. and continue daily thereafter. All ladies must first register with their husbands before they can sign up for the program and must present their identification badges. Hostesses will be in attendance from 8:30 to 4:00 to answer questions and to help everyone enjoy their visit to New York. Cards and bridge tables will be provided on request.

The highlight of Monday's entertainment will be a Get-Acquainted Tea from 4 to 5:30 p.m. sponsored by the Phelps-Dodge Copper Products Corporation. Tuesday will be a full day with the ever-popular United Nations Tour and Luncheon in the delegates dining room, an afternoon trip to the Hayden Planetarium, and ending with a Ladies' Dinner which will be preceded by a Cocktail Hour sponsored by the I-T-E Circuit Breaker Company. There will be entertainment, through the courtesy of Waterbury Company, Inc., and prizes at the dinner. Another interesting tour is planned for Wednesday and also a luncheon and bridge at a well-known hotel. The busiest day of the week will be Thursday which will start with breakfast and a hat show at Altman's Fifth Ave. Department Store and then a luncheon and fashion show at the world famous Waldorf-Astoria Hotel. This luncheon, sponsored by the John A. Roebling's Sons Corp., is complimentary and can be attended only by those holding admission tickets. Tickets reserved for this luncheon will not be held after 10:30 a.m. on Thursday. The Dinner-Dance will mark the end of a perfect day.

Winter General Meeting Committee

Members of the 1958 Winter General Meeting Committee are: D. M. Quick, chairman; R. T. Weil, Jr., vice-chairman; J. J. Anderson, secretary; L. F. Stone, budget co-ordinator and AIEE vice-president for District 3; H. Blackmon, chairman Technical Operations Department; J. A. Parrott, public relations; R. W. Gillette, general session; D. E. Winslow, hotel accommodations; T. C. Oliver, registration; J. A. Mulligan, inspection trips; R. R. Meola, monitors; H. B. Snow, smoker; W. F. Anselm, dinner-dance; Mrs. C. T. Hatcher, ladies entertainment; A. J. Cooper, ex-officio member (past-chairman).

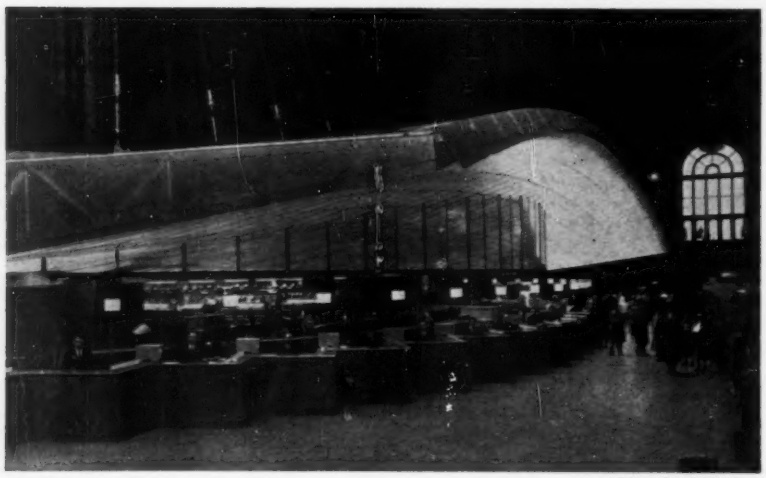


Photo by A. F. Soule

THE NEW TICKET SALES AND SERVICE BUREAU at Pennsylvania Station, New York, N. Y., combines a startling variety of electronic and mechanical devices designed to help make reservations, sell and deliver tickets, and give information more efficiently and more quickly than ever before attempted. Members of an inspection trip will visit the Ticket Sales and Service Bureau during the 1958 AIEE Winter General Meeting.

AIEE Winter General Meeting, New York, N.Y., February 2-7, 1958
Tentative Technical Program

Monday, February 3

9:00 a.m. Instrumentation for Electric Welding

CP.* Progress in Development of Recommended Practices for Resistance Welding. *R. P. C. Rasmusen*

CP-58-210. A Recommended Program for Resistance Welding Instrumentation. *A. Dixon,* Westinghouse Electric Corporation

CP.* A Parallel-Type Pickup Coil for Resistance Welding Current Measurements. *William Kolb*

9:00 a.m. Mining and Metal Industry

CP.* Recent Advances in Control Systems for Continuous Processing Lines. *C. P. Brooks, J. T. Bradford,* General Electric Company

CP.* Motor Field Control for Large Reversing Mill Motors. *L. R. Hulls,* Canadian Westinghouse Company

CP.* Some Experiences with Magnetic Amplifier Applications. *J. A. B. Pinney,* Alan Wood Steel Company

CP.* The Application of Electrode Positioning Controls for Vacuum Arc Melting Furnaces. *E. J. Borrebach,* Westinghouse Electric Corporation

9:00 a.m. Refining and Chemical Processes

CP.* Static Electricity in the Petroleum Industry. *J. C. Howard,* Standard Oil Company, (Indiana)

58-227. CYPAK and Its Application in the Petroleum and Chemical Industries. *P. G. Hanna, C. R. Olson,* Westinghouse Electric Corporation

CP58-228. Electrical Safety in the Chemical Industry. *E. J. Meyers,* E. I. DuPont de Nemours and Co., Inc.

CP.* Selection and Installation of Equipment for Conduit Wiring Systems in Corrosive Locations. *R. P. Northup, D. J. Smith,* Crouse-Hinds Company

9:00 a.m. Microwave Channel Requirements for Protective Relaying

Symposium Moderator: T. A. Cramer, General Electric Company

Introduction: G. E. Farmer, Tennessee Valley Authority

CP.* *H. W. Lensner,* Westinghouse Electric Corporation

CP.* *L. G. Walker,* Motorola, Inc.

CP.* *I. T. Corbell,* General Electric Company

CP.* *K. O. Sten,* Boston Edison Company

CP.* *E. W. Downer,* Cleveland Electric Illuminating Company

9:00 a.m. Protective Devices

58-69. Lightning Protection of Equipment with Remotely Mounted Arresters. *A. H. Knable,* Allis-Chalmers Manufacturing Company

57-575. Expanding System Requirements Indicate Need for More Severe Arrester Tests. *G. F. Lincks,* General Electric Company

*Conference Papers will not be printed by the Institute; however, they may be available at the meeting at the discretion of the author.

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58-160. Lighning Arrester Field Tests. *H. Linck,* The Hydro-Electric Power Commission of Ontario

CP58-56. The Frequency Spectrum in Impulse Testing. *W. J. McKune,* Georgia Institute of Technology

58-94. An Experience with Breaker Restriking and Arrester Destruction on the Pennsylvania Power and Light Co. 220-Kv System. *M. C. Galiyano, C. A. MacArthur, W. F. Mackenzie,* Pennsylvania Power and Light Company

9:00 a.m. Industrial Power Rectifiers

CP58-216. Performance of Pumpless Ignitron Rectifiers. *W. L. Blatz, E. J. Remscheid,* General Electric Company

58-137. Superposition Applied to Mechanical Rectifier Contacts. *I. K. Dortort,* I-T-E Circuit Breaker Company

CP58-217. Transformer Equipment for Rectifier Substations Serving Electrochemical Plants. *W. R. Hodgson, R. D. Morris,* Westinghouse Electric Corporation

58-218. Analysis of Ignitron Rectifiers for Reversing Mill Drives. *C. G. Hagensick, E. J. Cham,* Westinghouse Electric Corporation

CP.* Report of the Working Group on Revision of ASA C-34. *H. Winograd,* Allis-Chalmers Manufacturing Company

9:00 a.m. Gaseous Dielectrics

CP.* Recent Progress on Gaseous Dielectrics. *J. J. Chapman, L. J. Frisco,* Johns Hopkins University

CP.* On the Electric Strengths of Gases at High Pressure—I. Nitrogen. *P. K. Watson, A. H. Sharbaugh,* General Electric Company

CP.* Current Pulse Shapes of Discharges in Air Gaps Limited by Series Dielectrics. *J. C. Devins,* General Electric Company

CP.* Ionization in Gas Switching Tubes. *D. J. Rose,* Bell Telephone Laboratories

CP.* Experience with the AIEE Subcommittee Test Cell for Gaseous Dielectrics. *M. L. Manning,* Pennsylvania Transformer Company

9:00 a.m. Electronic Transformers

CP.* Computer Design of Small Electronic Transformers. *Wade Etchison, M. B. Meunier, Reuben Lee,* Westinghouse Electric Corporation

CP.* Reliability of Transformers for Electronic Applications. *O. L. Angevine,* Caledonia Electronics and Transformer Corporation

58-209. An Experimental Study of Magnetic Materials for Use in Ultra High Temperature Electronic Transformers. *H. B. Harms,* General Electric Company

CP58-208. Ultra High Temperature Electronic Transformers. *G. E. Walter, J. F. Rippin, Jr., H. B. Harms,* General Electric Company

9:00 a.m. Magnetic Amplifiers

58-120. Magnetic Saturable Core Timing Device. *J. L. Lowrance,* Bendix Aviation Corporation

57-921. Core-Reset Functions in Magnetic Amplifier Analysis—Part II. Determination of Amplifier Performance. *G. C. Feth,* General Electric Company

58-96. Self-Balancing Flux-Gate Magnetometers. *W. A. Geyger,* U. S. Naval Ordnance Laboratory

CP58-173. Volt-Second Transfer Efficiency in Fast Response Magnetic Amplifiers—Part II: N^2/R as a Design Parameter. *T. J. Pula, G. E. Lynn, J. F. Ringelman,* Westinghouse Electric Corporation

9:00 a.m. Digital Differential Analyzers

CP.* What Is a DDA? *R. Goldman,* Bendix Computer Division

CP.* Evaluation of DDA Techniques. *R. C. Minnick,* Burroughs Corporation

CP.* Future Developments in Incremental Techniques. *M. Palevsky,* Packard-Bell Computer Corporation

9:00 a.m. Recording and Controlling Instrumentation.

CP58-15. Digital Systems in the Aircraft Industry. *W. P. Hamilton,* Leeds and Northrup Company

58-29. Digital and Pictorial Photographic Electronic Recorder. *R. G. McPherson, I. A. Sonderby,* The Magnavox Research Laboratories

CP.* Problems in the Design of a Family of Automatic Null-Balancing Electrical Measuring Instruments. *L. E. Jewett,* Leeds and Northrup Company

CP.* Design Considerations for Miniature Automatic Null-Balancing Electrical Measuring Instruments. *D. A. Narducci, Jr.,* The Bristol Company

9:00 a.m. Indicating and Integrating Instruments

58-145. Watt-Hour Meter for Two Phases of a 4-Wire Y 3-Phase System. *A. M. McQuarrie,* General Electric Company

58-146. New Printing Demand Meter. *P. V. Terry,* General Electric Company

CP58-241. High Impulse Rate Demand Contact Device. *W. A. Cavagnaro, E. B. Judd,* General Electric Company

CP.* Evaluation of Single-Phase Metering Practices Based on Meter Performance and Load Characteristics. *J. M. Vanderleck,* The Hydro-Electric Power Commission of Ontario

2:00 p.m. General Session

Address: President W. J. Barrett

Presentation of the Institute Prize Paper Awards

Presentation of the Edison Medal to J. K. Hodnette, vice-president and general manager, Westinghouse Electric Corporation

Address: T. J. Watson, Jr., chairman of the board of directors, International Business Machines Corporation.

Tuesday, February 4

9:00 a.m. Section Representatives

9:00 a.m. Television and Aural Broadcasting

CP.* A New Industrial TV Camera System. *J. E. Dilley, G. A. Senior,* Radio Corporation of America

CP.* Dial Selective TV System for Ticket Reservation Facilities. *J. W. Alinsky,* Thompson Products, Inc.

CP.* Unusual Applications of Closed-Circuit Television. *C. L. Ellis,* General Electric Company

CP.* Wiring a Town for Closed-Circuit Movie Distribution. *H. J. McMains,* Southwestern Bell Telephone Company

9:00 a.m. Electric Space Heating and Heat Pumps

CP.* The Challenging Aspects of Electric Space Heating. *W. T. Richards,* Indianapolis Power and Light Company

58-64. Heat Pump and Heating Cables Installed in the Same Residence: First Year of Comparative Operation. *E. E. Linden, C. W. Jones,* The Narragansett Electric Company

CP.* Operating Cost Calculations and Experience of Air-to-Air Heat Pumps. *H. N. Eanes,* Alabama Power Company

CP.* Large Heat Pumps. *H. E. Rex,* Carrier Corporation

9:00 a.m. Industrial Power Rectifiers and Metallic Rectifiers

58-219. Current Balancing Reactors for Semiconductor Rectifiers. *I. K. Dortort,* I-T-E Circuit Breaker Company

58-220. Rectifier Power Factor. *A. Schmidt, Jr.,* General Electric Company

CP58-221. Semiconductor Rectifiers—Present and Future—for Electrochemical Loads. *R. M. Crenshaw, A. L. Munn,* General Electric Company

CP58-222. Design Considerations for Large Industrial Semiconductor Rectifiers. *G. J. Bowar,* General Electric Company

CP.* Trip Report on Rectifier Developments in Russia. *L. W. Morton,* General Electric Company

9:00 a.m. Insulated Conductors

58-72. Control of the Thermal Environment of Buried Cable Systems—II. *L. H. Fink, J. J. Smerke II,* Philadelphia Electric Company

CP58-242. Forced Cooling of Underground Cables. *O. Nigol, G. H. West,* The Hydro-Electric Power Commission of Ontario

58-73. 69-Kv Stop Joint for Connecting Pipe Type Cable to Oil-Filled Cable. *R. H. Bolling, Jr.,* Philadelphia Electric Company

58-74. Aluminum Conductor Aluminum Sheathed, Triplex Cable Installation. *J. F. Gillespie,* Philadelphia Electric Company.

9:00 a.m. Power Generation

58-93. Switchgear with Stored Energy Mechanism Applied to Steam Station Auxiliary Transfer Arrangements. *P. G. Brown, J. J. Heagerty, D. G. Lewis, E. M. Smith,* General Electric Company

58-53. Electrical Control Features of the Avon Supercritical Pressure Unit. *R. F. Willett,* Cleveland Electric Illuminating Company

CP58-163. Design and Operation of Gas Turbine Operating Stations. *A. W. Barstow, W. D. Marsh,* General Electric Company

58-164. Large Gas Turbines for Central Station Application. *Z. S. Stys,* Brown Boveri Corporation

9:00 a.m. Substations

58-98. Voltage Gradients through the Ground under Fault Conditions. AIEE Working Group 56.1. Chairman, R. F. Stevens

58-33. The Economic Advantages of Standard Substations. *B. T. Payne,* Central Maine Power Company

58-7. Working Group Report on Mobile Substations—Their Use, and the Design of Distribution Substations To Facilitate Their Use. AIEE Substations Committee Working Group —Project 53.2, Chairman H. H. Marsch, Jr.

CP58-99. Design and Utilization of Mobile Substations. *M. R. Wallin,* Union Electric Company

9:00 a.m. Applied Mathematics

CP.* Generalized Recurrence Relations in the Analysis of Physical Nonlinear Systems. *A. A. Wolf,* University of Pennsylvania

CP.* Transient Response of a Saturating Control System. *J. H. Dietz, A. A. Wolf*

58-66. Matrix Programming of Electronic Analogue Computers. *R. E. Horn,* Westinghouse Electric Corporation; *P. M. Honnell,* Washington University

CP58-67. Solutions of the Stout Nonlinear Equations and the Lewis Nonlinear Equation by Number Series. *J. R. Eckel, Jr.,* University of Wisconsin; *C. H. Weaver,* University of Tennessee

9:00 a.m. High-Temperature Insulation

58-115. Properties of Electrical Insulation at Ultra High Temperatures. *G. I. Duncan, M. M. Felger,* General Electric Company

58-116. Dielectric Sample Holder for Thin Sheet Insulation to 600C. *M. C. Halleck,* General Electric Company

CP58-117. Magnet Wire for Ultra High Temperature Transformers. *W. W. Wareham,* General Electric Company

CP58-118. Terminal Spacings for High Altitude and Ultra High Temperature Electronic Transformer Applications. *G. I. Duncan, W. A. Rectanus,* General Electric Company

58-119. Insulation Aging in Pure Oxygen and in a Vacuum. *L. C. Whitman,* General Electric Company

9:00 a.m. Electron Tube Developments

CP58-187. Low-Mu Triodes with Improved Electrode Geometry. *C. V. Weden,* Machlett Laboratories Inc.

CP.* High Temperature Ceramic Voltage Regulators and Reference Tubes. *J. M. Lafferty,* General Electric Research Laboratory

CP58-188. Ceramic Hydrogen Thyratons. *H. N. Price, A. W. Coolidge,* General Electric Company

CP.* A Rugged Tunable, Thermally Stable X-Band Beacon Magnetron. *C. J. Orlebeke,* Raytheon Manufacturing Company

9:00 a.m. Magnetic Amplifiers

58-39. Magnetic Amplifier Design—Part II. The Windings. *R. E. Anderson,* General Electric Company

58-77. High Efficiency Push-Pull Magnetic Amplifiers with Transistors as Switched Rectifiers. *A. G. Milnes,* Carnegie Institute of Technology

58-175. Proposed Standard Terms and Definitions for Magnetic Amplifiers. AIEE Definitions Subcommittee, *D. Feldman,* chairman

58-71. Proposed Standards for Core Test Methods for Toroidal Magnetic Amplifier Cores. AIEE Committee Report by Core Matching and Grading Working Group, *V. J. Louden,* chairman

9:00 a.m. Computing Devices and System Engineering

58-133. Computer Analysis of Transmission System Capability during Generator Outrages. *H. B. Seeley, R. E. Briesemeister, J. T. Garbarini,* Consolidated Edison Company of New York, Inc.

58-134. The Use of a Digital Computer in a Generator Reserve Requirement Study. *H. E. Brown,* Commonwealth Edison Company

CP58-136. Digital Fault Calculations. *C. F. Evert, W. M. Lampe,* University of Cincinnati

CP.* Experience in Computation of Load Flow Studies Using High Speed Computer. *H. P. St. Clair, G. W. Stagg*

CP58-243. Preliminary Report on Survey of Electric Utility Applications of Digital Computers. Computer Applications Subcommittee of System Engineering Committee and Applications Subcommittee of Computing Devices Committee, AIEE

9:00 a.m. Recording and Controlling Instrumentation

Topic: ASA Specifications (C39.4-1956) for Automatic Null-Balancing Electrical Measuring Instruments.

Presentation: Members of the ASA Subcommittee C39.4 responsible for this new standard will review the reasoning on which it was based and will respond to questions concerning it.

Participants: Chairman: E. A. Weiss, Sun Oil Co. Panel Members: H. C. Koenig, Electrical Testing Laboratories; G. L. Broomell, Jr., Leeds and Northrup Company; R. C. Langford, Weston Electrical Instrument Corporation; J. W. Percy, U.S. Steel Corporation; W. H. Brand, Conoflow Corporation.

2:00 p.m. Section Representatives

2:00 p.m. Television and Aural Broadcasting

CP.* A New Vidicon Camera for Live Pickup. *F. W. Millspaugh, J. H. Roe,* Radio Corporation of America

CP.* Effects of Local Conditions on TV Receiver Design. *Ernest Freeland,* Philco Corporation

CP.* Engineering for Off-the-Air Television Service in Southern California. *E. D. Barcus,* Pacific Telephone and Telegraph Company

2:00 p.m. Marine Transportation

58-135. Metallic Rectifiers for Shipboard Electrical Systems. *C. L. Straub,* U.S. Navy Department; *H. G. Wiest,* General Electric Company

58-132. Overcurrent Protection in Large Capacity Shipboard Electrical Systems. *J. R. Cole,* Department of the Navy

AIEE Future Meetings

AIEE-IRE-ASQC Reliability and Quality Control Conference*
Statler Hotel, Washington, D. C.
January 6-8, 1958

AIEE-IRE-AEC-NBS Scintillation Counter Symposium*
Shoreham Hotel, Washington, D. C.
January 27-28, 1958

Winter General Meeting*
Hotel Statler, New York, N. Y.
February 2-7, 1958

AIEE-IRE-U of P Transistor and Solid State Circuits Conference*
Philadelphia, Pa.
February 20-21, 1958

Textile Conference
Georgia Institute of Technology
Atlanta, Ga.
March 13-14, 1958
(Final date for †TP—closed, ‡CP Syn.—closed, CPMs—Jan. 7)

EJC Nuclear Congress
International Amphitheatre
Chicago, Ill.
March 17-21, 1958
(Final date for †TP—closed, ‡CP Syn.—Jan. 1, CPMs—Jan. 10)

AIEE-ASME Engineering Management Conference
Boston, Mass.
March 19-20, 1958
(Final date for †TP—closed, ‡CP Syn.—Jan. 3, CPMs—Jan. 13)

American Power Conference
Sherman Hotel, Chicago, Ill.
March 26-28, 1958
(Final date for †TP—closed, ‡CP Syn.—closed, CPMs—Jan. 31)

Pulp and Paper Conference
North Carolina State College
Raleigh, N. C.
March 27-29, 1958
(Final date for †TP—closed, ‡CP Syn.—Jan. 15, CPMs—Jan. 24)

South West District Meeting
Mayo Hotel
Tulsa, Okla.
March 31-April 2, 1958
(Final date for †TP—closed, §DP Syn.—Jan. 8, DPMs—Jan. 13)

AIEE-ASME-IRE-ISA-AIChE Automatic Optimization Conference
University of Delaware
Newark, Del.
April 2-4, 1958
(Final date for †TP—closed, ‡CP Syn.—Jan. 17, CPMs—Jan. 27)

AIEE-ASME Railroad Conference
Cleveland, Ohio
April 9-10, 1958
(Final date for †TP—closed, ‡CP Syn.—Jan. 24, CPMs—Feb. 3)

Rubber and Plastics Conference
Mayflower Hotel
Akron, Ohio
April 14-15, 1958
(Final date for †TP—Jan. 3, ‡CP Syn.—Jan. 28, CPMs—Feb. 7)

AIEE-IRE-ASME Automatic Techniques Conference (Automation and Data Processing)
Statler Hotel
Detroit, Mich.
April 14-16, 1958
(Final date for †TP—Jan. 3, ‡CP Syn.—Feb. 25, CPMs—Feb. 7)

AIEE-IRE-EIA-WCEMA Joint Electronic Components Conference
Ambassador Hotel
Los Angeles, Calif.
April 22-24, 1958
(Final date for †TP—Jan. 10 ‡CP Syn.—Feb. 5, CPMs—Feb. 15)

Middle Eastern District Meeting
Washington, D. C.
April 28-30, 1958
(Final date for †TP—Jan. 17, §DP Syn.—Feb. 7, DPMs—Feb. 11)

Great Lakes District Meeting
Michigan State University
East Lansing, Mich.
May 5-7, 1958
(Final date for †TP—Jan. 24, §DP Syn.—Feb. 7, DPMs—Feb. 11)

AIEE-IRE-ACM Western Joint Computer Conference (Exhibit)
Ambassador Hotel
Los Angeles, Calif.
May 6-9, 1958
(Final date for †TP—Jan. 24, ‡CP Syn.—Feb. 18, CPMs—Feb. 28)

East Central District Meeting
Huntington, W. Va.
May 13-15, 1958
(Final date for †TP—Jan. 31, §DP Syn.—March 7, DPMs—March 11)

Materials Handling Conference
Pittsburgh, Pa.
May 19-20, 1958
(Final date for †TP—Feb. 7, ‡CP Syn.—March 4, CPMs—March 14)

Domestic Appliances Conference
Hotel Morrison
Chicago, Ill.
May 26-28, 1958
(Final date for †TP—Feb. 14, ‡CP Syn.—March 11, CPMs—March 21)

AIEE-ISA-IAS-ARS National Telemetering Conference (Exhibit)
Lord Baltimore Hotel
Baltimore, Md.
June 2-4, 1958
(Final date for †TP—Feb. 21, ‡CP Syn.—March 18, CPMs—March 28)

Summer General Meeting
Buffalo, N. Y.
June 22-27, 1958
(Final date for †TP—March 14, ‡CP Syn.—April 3, CPMs—April 7)

AIEE-IRE Nonlinear Magnetics and Magnetic Amplifiers Conference (Exhibit)
Los Angeles, Calif.
August 5-8, 1958
(Final date for †TP—April 25, ‡CP Syn.—May 20, CPMs—May 30)

Pacific General Meeting
Sacramento, Calif.
August 19-22, 1958
(Final date for †TP—May 9, ‡CP Syn.—June 3, CPMs—June 6)

Petroleum Industry Conference
Baker Hotel
Dallas, Texas
September 15-17, 1958
(Final date for †TP—June 6, ‡CP Syn.—July 1, CPMs—July 11)

AIEE-IRE-ASME National Power Conference
Boston, Mass.
September 28-October 1, 1958
(Final date for †TP—June 20, ‡CP Syn.—July 15, CPMs—July 25)

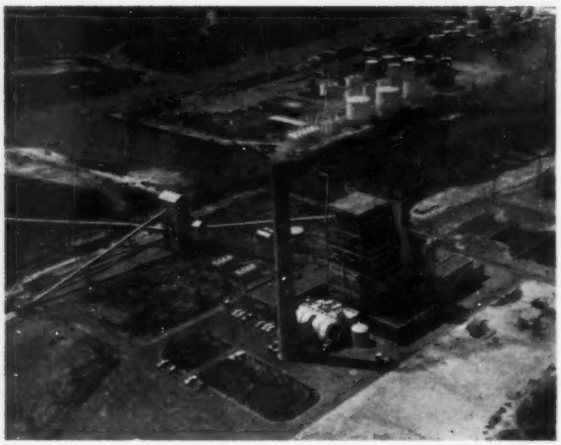
AIEE-IRE-EIA-SMPTE National Electronics Conference
Chicago, Ill.
October 13-15, 1958
(Final date for †TP—July 4, ‡CP Syn.—July 29, CPMs—Aug. 8)

Machine Tools Conference
Statler Hotel
Hartford, Conn.
October 13-15, 1958
(Final date for †TP—July 4, ‡CP Syn.—July 29, CPMs—Aug. 8)

Fall General Meeting
Pittsburgh, Pa.
October 26-31, 1958
(Final date for †TP—June 27, ‡CP Syn.—Aug. 4, CPMs—Aug. 8)

AIEE-IRE-ACM Eastern Joint Computer Conference (Exhibit)
Bellevue-Stratford Hotel
Philadelphia, Pa.
December 3-5, 1958
(Final date for †TP—Aug. 25, ‡CP Syn.—Sept. 19, CPMs—Sept. 29)

*Final date for submitting papers—closed
†TP—Transactions Paper
‡CP Syn.—Conference Synopsis
CPMs—Conference Manuscript
§DP Syn.—District Synopsis
(District Paper Synopses should be directed to the District Meeting Committee)
DPMs—District Manuscript



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THE Edward F. Barrett Power Station, Long Island Lighting Co., Island Park, L. I., N. Y., will be visited during an AIEE Winter General Meeting inspection trip.

CP58-161. Recommendations for Electrical Installations in Ships. I.E.C. Publication 92

2:00 p.m. Industrial Power Systems and Transmission and Distribution

CP.* Alternate Methods of Tying with Utilities. *T. W. Haymes, Robert Thompson*

CP58-63. Electrical Problems Resulting from the Interconnection of a Steel Plant Power System and a Utility. *E. J. McClure*

CP.* A-C Network Analyzer Studies of Interconnected Utility and Industrial Power Systems. *C. C. Young, J. Dunki-Jacobs*

57-642. The Tie between a Utility and an Industrial when the Industrial Has Generation. *D. V. Fawcett*, Canadian Westinghouse Co., Ltd. (Re-presented for discussion only)

2:00 p.m. Insulated Conductors

58-75. Corrugated Metallic Cable Sheath. *K. Andresen*, Hackethal Draht-und Kabel-Werke AG; *F. Dias, N. D. Kenney*, Simplex Wire and Cable Company

58-76. Electromagnetic Field Phenomena in Shielded Aerial Cables under Surge Conditions. *J. K. Delson*, General Electric Company

58-51. Dielectric Strength and Voltage Life of Polyethylene. *G. H. Hunt, M. J. Koulopoulos, P. H. Ware*, Simplex Wire and Cable Company

CP.* Operating Experience with Thermoplastic Insulated Wire and Cable in Chemical Plants. *M. M. Gilbert, J. R. Perkins*, E. I. du Pont de Nemours & Co. (Inc.)

2:00 p.m. Power Generation

CP.* Recommended AIEE Excitation Systems Definitions for Synchronous Systems. Excitation Systems Subcommittee

57-994. Transient Performance of Excitation Systems. *R. L. Krahn*, U.S. Army Corps of Engineers

CP.* A Static Annunciator System. *W. H. Baker*, Public Service Electric and Gas Co.; *E. A. Sagan*, Westinghouse Electric Corporation

2:00 p.m. Substations

CP58-100. Advantages of Conventional Substation Construction. *P. R. Harris*, Southwestern Gas & Electric Co., Shreveport, La.

CP58-244. Virginia Electric & Power Company Prefers Conventional Substations. *A. H. Thiermann, Jr.*, Virginia Electric & Power Company

CP.* Single Circuit Unit Substations. *J. F. Jones*, Baltimore Gas & Electric Company

CP58-101. The Hartford Electric Light Company Prefers Unit Substations. *D. C. Switzer*, Hartford Electric Light Co.; *H. B. Wortman*, Westinghouse Electric Corporation

2:00 p.m. Electric Circuit Theory

58-52. Certain Applications of Matrixes to Circuit Theory. *L. A. Pipes*, University of California

CP58-60. A Circuit Theory Approach to Finite Difference Stability. *W. J. Karplus*, University of California

CP58-61. Duality and Mutual Inductance. *L. Brenner, R. Stein*, The City College

58-65. Accurate Determination of Capacitance by Conjoining Analytical and Analog Techniques. *J. D. Horgan, J. A. Pesavente*, Marquette University

2:00 p.m. Thermal Stability of Insulation

CP.* Problems in Evaluating Long-Term Degradation of Insulation. *K. N. Mathes*, General Electric Company

CP.* Thermal Life of Enameled Magnet Wire. Report by Enameled Magnet Wire Working Group, *J. F. Dexter*, chairman

CP.* The Evaluation of Enameled Magnet Wire. *H. L. Saums, W. W. Pendelton*, Anaconda Wire and Cable Company

CP.* The Effect of Varying the Electrode Curvature in Testing the Thermal Flex Life of Insulating Varnishes. *R. L. Bowman*, Minnesota Mining and Manufacturing Company

CP.* The Statistical Evaluation of Life Test Data by a 650 Digital Computer. *L. P. Mahon*, Canadian General Electric Company

2:00 p.m. Electron Tube Evaluation Program

CP.* Evaluation of Control Grid Current in Radio Tubes. *L. T. May*, Tung-Sol Electric Inc.

CP.* Electron Tube Evaluation for Guided Missile Applications. *H. G. Chandler*, Diamond Ordnance Fuze Laboratories

CP.* The Role of Customer–Vender Agreements in the Maintenance of Electron Tube Quality Levels. *A. Warsher*, Bendix Aviation Corporation

CP.* Field Failure Analysis and Its Effect on Electron Tube Reliability. *N. E. Nitschke*, International Business Machines Corporation

CP.* Improvement of Electron Tube Quality through Receiving Inspection and Failure Analysis. *M. Swadow*, Westinghouse Electric Corporation

2:00 p.m. Magnetic Amplifiers

58-177. Introducing Young Engineers to the Appreciation of Magnetic Amplifier Problems. *L. A. Finzi*, Carnegie Institute of Technology

58-178. The Transactor, a Self Saturating Transformer, Part I. *A. B. Rosenstein*, Los Angeles, Calif.

58-180. Applications of Nonlinear Magnetics. *H. F. Storm*, General Electric Company

2:00 p.m. Research

Topic: "The Engineering Foundation and University Research"

CP.* The Aims and Activities of the Engineering Foundation. *E. I. Green*, Bell Telephone Laboratories

CP.* The Role of the Universities in Engineering Research. *W. L. Everitt*, University of Illinois

CP.* 345-Kv Power Cable Research, An Example of University and Industry Co-operative Research. Report of AEIC-EEI Steering Committee for the Project

2:00 p.m. Techniques for Dielectric Tests

58-110. Surge Measurement Errors Introduced by Coaxial Cables. *J. H. Park*, National Bureau of Standards

58-18. Measurements of Steep-Front Impulse Waves with an Isolated Screen Room Installation. *C. J. Miller, Jr., J. F. Wittibschlager*, The Ohio Brass Company

58-37. Transient Response of Impulse Voltage Dividers. *F. A. Fisher*, General Electric Company

58-27. The Influence of Water Resistivity and Precipitation Rate upon 60-Cycle Wet Flashover Voltage. AIEE Working Group on Rain Tests, Chairman, C. J. Miller, Jr.

Wednesday, February 5

9:00 a.m. Radio Communications and Television and Aural Broadcasting

CP.* Mobile Dialing. *C. H. Willyard*, Motorola Inc.

58-179. Wideband UHF Over-the-Horizon Equipment. *R. A. Felsenheld, H. Havstad, J. L. Jatlow, D. J. LeVine, L. Pollack*, Federal Telecommunication Laboratories

58-154. The Miami–Havana Radio System and Its Integration into the Telephone Networks. *K. P. Stiles, F. G. Hollins, E. T. Fruhner, W. D. Siddall*, American Telephone and Telegraph Company

CP.* Factors Affecting the Use of Over-the-Horizon Links in Telecommunication Networks. *Charles Parry*, Page Communications Engineers, Inc.

CP.* Beyond Horizon Radio—Tailored for Alaska. *R. B. Stecker*, Western Electric Company

9:00 a.m. Industrial Control

CP58-62. The Bode Diagram—An Approach to Regulating System Stability Fundamentals. L. A. Koenig, Clark Controller Company

58-42. A Method of Scaling and Checking Computer Circuits. *L. J. Lane*, General Electric Company

CP58-79. A Computer Study of a High-Speed Repetitive Positioning Drive. *E. G. Anger*, Square D Company

58-40. Characteristics of Phase-Controlled Bridge Rectifiers with D-C Shunt Motor Load. *R. W. Pfaff*, Reliance Electric and Engineering Company

9:00 a.m. Insulated Conductors

58-17. Cable Installations on Bridges. *E. W. Scheirer, L. Winitsky*, Philadelphia Electric Company

58-78. The St. Lawrence River High Voltage Submarine Cable Crossing—Part I, Basic Data and Design. *D. M. Farnham*, Quebec Hydro Electric Commission, *G. B. Shanklin*, Schenectady, N.Y.; *S. H. Cunha*, Quebec Hydro Electric Commission; *H. D. Short*, Canada Wire and Cable Company, Ltd. (Re-presentation by title only)

CP.* The St. Lawrence River High Voltage Submarine Cable Crossing—Part II, Experimental Program and Cable Manufacture. *D. M. Farnham*, Quebec Hydro Electric Commission; *G. B. Shanklin*, Schenectady, N.Y.; *S. H. Cunha*, Quebec Hydro Electric Commission; *H. D. Short*, Canada Wire and Cable Company, Ltd.

CP.* The St. Lawrence River High Voltage Submarine Cable Crossing—Part III, Installation. *D. M. Farnham*, Quebec Hydro Electric Commission, *G. B. Shanklin*, Schenectady, N.Y.; *S. H. Cunha*, Quebec Hydro Electric Commission; *H. D. Short*, Canada Wire and Cable Company, Ltd.

CP.* The St. Lawrence River High Voltage Submarine Cable Crossing—Part IV, Final Tests and Field Data. *D. M. Farnham*, Quebec Hydro Electric Commission; *G. B. Shanklin*, Schenectady, N.Y.; *S. H. Cunha*, Quebec Hydro Electric Commission; *H. D. Short*, Canada Wire and Cable Company, Ltd.

9:00 a.m. Power Generation and System Engineering

58-126. Determination of Reserve Generating Capability. *H. Halperin, H. A. Adler*, Commonwealth Edison Company

58-139. Determination of Reserve and Interconnection Requirements. *H. D. Limmer*, Public Service Electric and Gas Company

58-140. Details of Outage Probability Calculations. *A. L. Miller*, The Cleveland Electric Illuminating Company

56-635. Probability Calculations for System Generation Reserves. *Carl Kist, G. J. Thomas*, Los Angeles Dept. of Water and Power

9:00 a.m. Substations and Switchgear

58-28. Welded Aluminum Conductors in Isolated Phase Bus. *N. Swerdlow, K. N. Smith*, General Electric Company

CP58-245. Power Tests Prove Single Insulator Isolated Phase Aluminum Bus. *A. H. Powell, N. Swerdlow*, General Electric Company

CP58-124. Application of Aluminum in Switchgear Apparatus. *R. H. Rutter, L. E. Keck*, Westinghouse Electric Corporation

CP58-125. Training and Qualification of Welders for Aluminum Bus Welding. *G. Allen*, Kaiser Aluminum Chemical Company

CP.* Design Concepts in the Development of Bolted Aluminum Power Connectors. *J. R. Warren*, Roval Electric Manufacturing Company, Inc.

9:00 a.m. Relays

58-25. Relaying Tapped Substations for Faults on High Voltage Transmission Lines. *R. W. World, C. L. Rose, J. E. Skuderna*, Bureau of Reclamation

58-26. Compensator Distance Relaying I—General Principles of Operation. *W. K. Sonnemann, H. W. Lensner*, Westinghouse Electric Corporation

58-20. Compensator Distance Relaying II—Design and Performance. *W. E. Rich, H. J. Calhoun*, Westinghouse Electric Corporation

58-19. Compensator Distance Relaying III—Carrier Control System. *H. W. Lensner, P. J. Schwanenflugel, W. L. Hinman*, Westinghouse Electric Corporation

9:00 a.m. New Synthetic Insulating Materials

CP.* Properties of Octofluorocyclobutane—A Dielectric Gas. *F. B. Hill*, E. I. du Pont de Nemours & Company (Inc.)

CP.* A New High Temperature Perfluorocarbon Resin for Conventional Thermoplastic Processing. *R. S. Lovett, Miles Powell, Jr.*, E. I. du Pont de Nemours & Company (Inc.)

CP.* A Versatile New Acetal Resin for Engineering Use. *E. F. Hamilton, Jr.*, E. I. du Pont de Nemours & Company (Inc.)

CP.* Acrylic Resin Insulation. *P. F. Sanders, V. R. Huntsberger, R. R. Storrow*, E. I. du Pont de Nemours & Company (Inc.)

9:00 a.m. Linear Transistor Applications

58-192. Temperature Stabilization of D-C and Switching Transistor Amplifiers. *Louis Depian*, George Washington University; *R. E. Smith*, Carnegie Institute of Technology

CP.* An Analog Frequency Measuring Circuit Accurate to 0.1%. *Jonathan Mitchell*, Link Aviation, Inc.

CP.* Transistor Phase Locked Oscillator. *D. J. Brady, K. A. Edwards, O. Golubjatnikov*, General Electric Company

CP.* Active Filters and their Use in Radar Range Gate Systems. *Harold Gruen*, Philco Corporation

9:00 a.m. Auxiliary Devices for Computers

CP.* Recognition of Magnetic Characters. *E. C. Greenius*, International Business Machines Corporation

CP.* A New Output Printer—Whippet. *G. Harris, H. Epstein*, Burroughs Corporation

CP.* A Photoelectric Analog-to-Digital Conveter Using a Complementary Code Pattern. *B. D. Merrill, R. Mugni*, Electronic Corporation of America

CP58-230. A Simulation of the Card Programmed Calculator on the IBM 705. *S. G. Fleming*, General Electric Company

9:00 a.m. Management

9:00 a.m. Special Instruments and Auxiliary Apparatus and Indicating and Integrating Instruments

58-8. Electric Hygrometer. *W. H. Meiklejohn*, General Electric Research Laboratory

CP58-103. Resistance Determination of Resistance Thermometers at Interval Temperatures. *J. Knudsen*, Lewis Engineering Company

CP.* Techniques for Measuring Small Three-Terminal Capacitors. *M. C. McGregor*

58-11. The Definition and Measurement of the Time Constant and Response Time of Thermal Converters. *F. L. Hermach*, National Bureau of Standards (Re-presented for discussion only)

CP.* A Unit for Checking A-C Indicating Instruments. *H. N. Haywood*

9:00 a.m. Industrial Power Rectifiers

CP58-223. Comparison of Calculated and Measured Arc-Back Current in Large Power Rectifier Systems. *J. Teno*, Lehigh University; *C. H. Titus*, General Electric Company; *R. N. Wagner*, Aluminum Company of America

CP58-224. Anode Breaker Field Testing with a High Capacity Rectifier System. *L. J. Harris*, Aluminum Company of America; *T. J. Scully, V. N. Stewart*, General Electric Company

CP58-225. Field Testing D-C Air Circuit Breakers on a High Capacity System. *P. L. Hartsock*, Aluminum Company of America; *T. J. Scully, V. N. Stewart*, General Electric Company

CP58-226. A Mathematical Model and Procedure for Arc-Back Current Calculations for Power Rectifiers. *H. P. Fullerton*, General Electric Company; *J. Teno*, Lehigh University

9:00 a.m. Ground Resistance and Potential Gradient Measurements

CP58-105. The Technique and Instrumentation of Low-Impedance Ground Measurement. *C. A. Duke, E. E. Smith*, Tennessee Valley Authority

CP58-106. Some of the Fundamental Aspects of Ground Resistance Measurements. *E. B. Curdts*, James G. Biddle Company

CP.* Resistance Measurements of Deep Driven Grounds. *C. H. Jensen*

CP.* Ground Measurements for Communication Circuit Protection Planning. *W. C. Ball*

2:00 p.m. Radio Communications Systems

CP.* Dial-Direct Automatic Termination Equipment for Mobile Radiotelephone Service. *J. A. Craig*, Dumont Manufacturing Company

CP58-181. A 6,000-Mc Radio System for Toll Telephone Service. *M. H. Kebby, A. F. Culbertson*, Lenkurt Electric Company

CP58-182. A 240-Channel Microwave Radio Multiplex System. *A. Hemmila, R. L. Edens*, Lenkurt Electric Company

CP.* Signaling Systems for Dialing and Supervision on Overseas Radiotelephone Systems. *E. W. Reeve*, American Telephone and Telegraph Company

58-183. The Simultaneous Transmission of Television and Telephone Multiplex Over a Single Microwave Channel on the Trans-Canada *TD-2* System. *H. E. Curtis*, Bell Telephone Co. of Canada; *A. J. Wade*, Bell Telephone Co. of Canada (Re-presented for discussion only)

CP58-184. An Automatic Frequency Control System Suitable for Single-Sideband Receivers and Frequency Modulation Transmitters. *L. R. Kahn*, Kahn Research Laboratories (Re-presented for discussion only)

58-185. A New Broadband Microwave Antenna System. *R. W. Friis, A. S. May*, Bell Telephone Laboratories (Re-presented for discussion only)

2:00 p.m. Communication Theory

58-34. Bits of Information. *A. S. Zamanakos*, United States Naval Research Laboratory

CP58-36. Entering the Machine Domain. *S. L. Seaton*

CP.* Recent Progress in Applying Information Theory to Digital Transmission Systems. *R. F. J. Filipowsky*, Westinghouse Electric Corporation

CP58-246. Binary Communication Feedback Systems. *B. Harris, A. Hauptschein, K. Morgan, L. S. Schwartz*, New York University

57-1041. Binary Symmetric Decision Feedback Systems. *B. Harris, K. C. Morgen*, New York University (Re-presented by title only)

58-38. An Experimental Study of a Binary Code. *W. W. Peterson*, University of Florida (Re-presented by title only)

2:00 p.m. Telegraph Systems

58-47. Airborne Teletypewriter, AN/AGC-1. *R. A. Michals,* Kleinschmidt Laboratories Inc.

58-48. The "Mite" Teleprinter. *Bernard Howard,* Teleprinter Corporation

CP.* Advancements in the Facsimile Art During 1957. *W. H. Bliss,* Radio Corporation of America Laboratories

CP.* Present Status of Facsimile in Japan. *Yasujiro Niwa,* Tokyo Electrical Engineering College

2:00 p.m. Industrial Control

58-68. Three-Phase Induction Motor Control Using Static Frequency Doublers. *A. Straughen,* Canadian Controllers Ltd.; *P. P. Biringer, G. R. Slemon,* University of Toronto

CP58-70. An Improved Static Digital Control System. *J. J. McNeill, H. A. Perkins, Jr.,* Westinghouse Electric Corporation

CP.* Proximity Switches—Characteristics Design and Application. *F. A. Manners, R. C. Mierendorf,* Square D Company

2:00 p.m. Power Generation and System Engineering

58-141. Generator Unit Size Study for the Dayton Power and Light Company. *L. K. Kirchmayer, A. G. Mellor, H. O. Simmons, Jr.,* General Electric Company

58-142. Digital Computer Aids Economic-Probabilistic Study of Generation Systems—Part I. *M. K. Brennan, C. D. Galloway, L. K. Kirchmayer,* General Electric Company

58-143. Digital Computer Aids Economic-Probabilistic Study of Generation Systems—Part II. *C. D. Galloway L. K. Kirchmayer,* General Electric Company

CP58-144. Treatment of Hydro Capability Duration Curves in Probability Calculations. *K. L. Hicks,* Sargent and Lundy

2:00 p.m. Rotating Machinery

58-195. A Theory for Shaded Pole Motors. *F. W. Suhr,* General Electric Company. (Represented by title only)

CP58-196. Temperature Tests on Totally Enclosed Nonventilated Motors. *R. F. Woll,* Westinghouse Electric Corporation

CP.* New Class F Wire Enamel-Varnish Systems. *J. R. Learn, R. B. Young,* General Electric Company

2:00 p.m. Transmission and Distribution and Relays

58-50. Ultrahigh-speed Reclosing Experience at 345 Kv. *H. C. Barnes, A. Hauspurg, J. H. Kinghorn,* American Gas and Electric Service Corporation

58-111. Effect of Current Cut-Off and Arc Voltage on Recovery Voltage. *C. Concordia,* General Electric Company

58-9. Bibliography on Power Capacitors 1954-1956. AIEE Working Group of the Capacitor Subcommittee, Chairman *M. E. Scoville*

2:00 p.m. Solid Dielectrics

CP.* Glass Flake in Electrical Insulation. *L. M. Conklin, M. P. Koerner, Jr.,* Owens Corning Fiberglas Corporation

58-121. Treeing in Polyethylene as a Prelude to Breakdown. *D. W. Kitchin, O. S. Pratt,* Simplex Wire and Cable Company

CP58-211. Internal Oxidation Mechanism for Nontracking Organic Insulations. *R. S. Norman, A. A. Kessel,* General Electric Company

58-122. Effect of Hydrostatic Pressure on the Permitivity of Barium Titanate Ceramics. *G. W. Marks, L. A. Monson,* United States Navy Electronics Laboratory

CP.* Electrical Characteristics of High Density, High Purity, Titanate Ceramics. *D. A. Lupfer,* General Electric Company

2:00 p.m. Theory and Design of Switching Circuits

58-3. Minimization of Components in Electronic Switching Circuits. *T. J. Beatson,* General Electric Company

CP58-193. The Effects of Semiconductor Diode Transients on Computor Gates. *H. A. Spang III,* Yale University School of Engineering

CP.* Collector Response Time from Characteristic Curves. *J. E. Palmer, J. E. Lindsay,* Radio Corporation of America

CP.* Monostable Multivibrator Pulse Generators. *J. J. Suran,* General Electric Company

CP58-194. Circuit Properties of Hook Transistor Configurations. *L. M. Vallese,* Polytechnic Institute of Brooklyn

CP.* Analysis and Design of a Transistor Linear Delay Circuit. *R. P. Nanavati,* Syracuse University

2:00 p.m. Nucleonics—Symposium on Effects of Radiation on Materials

CP.* Radiation Damage to Insulators. *J. F. Kircher,* Battelle Memorial Institute

CP.* Effects of Radiation on Electronic Components. *J. C. Pigg,* Oak Ridge National Laboratory

CP.* The Argonne High-Level Gamma Irradiation Facility. *H. Swope,* Argonne National Laboratory

CP.* Effect of In-Pile Radiation on Ceramic Triode. *J. R. Crittenden,* General Electric Company

2:00 p.m. Computers in Control Systems

58-31. An Analog Computer Study of the Transient Behavior and Stability Characteristics of Serial Type Digital Data Systems. *O. I. Elgerd,* University of Florida

CP58-231. Function Tables in Digital Control Computers. *E. J. Schubert,* Burroughs Research Center

CP58-232. A Transistorized Digital Control System with Precision Indication of the Controlled Variable. *W. M. Kaufman, T. A. Jeeves,* Westinghouse Research Laboratories

58-247. Design of Function Generators Using Short-Time Memory Devices and Non-Linear Elements. *A. W. Revay,* U. S. Air Force; *D. J. Ford,* University of Pittsburgh

2:00 p.m. Industrial Power Systems

CP.* Recent Advances in Busway Concepts. *C. J. Falk, C. A. Brown*

CP58-102. Voltage Drop Determinations Examined. *R. A. Erwin,* Los Angeles Department of Water and Power

CP.* Power Distribution at Vancoram Plant, Vanadium Corporation of America *F. G. Fellows, H. F. White*

CP.* Power Systems for Small Plants Served at Above 15 Kv. *D. B. Armstrong, L. H. Greutzmacher*

CP58-16. High Voltage Power Distribution Systems for Schools. *D. T. Michael,* Cincinnati Gas and Electric Company

2:00 p.m. Measurements on Dielectrics

CP58-107. Ionization Pulse Detection with a Slow-Sweep-Speed Oscilloscope. *C. A. Duke, L. E. Smith,* Tennessee Valley Authority

58-35. Measurement of Voltage Resulting from Single Phase Switching of a High Voltage 3-Phase Transformer. *W. F. Dunkle, W. F. Mackenzie,* Pennsylvania Power and Light Company

CP58-49. The Development of Power Factor Measurement of Insulation in the Field. *E. H. Povey,* Doble Engineering Company

CP58-108. Turboalternator Cylindrical Rotor Winding Tester. *E. E. Stamm,* Consolidated Edison Company

Thursday, February 6

9:00 a.m. Symposium on Safety Considerations in the Proposed Use of Higher Secondary and Utilization Voltages

A. E. Pringle, II, Symposium Moderator

National Electrical Code. *H. B. Whitaker*

Industrial and Commercial Buildings. *R. H. Kaufmann*

Relative Shock Hazard. *W. B. Kouwenhoven*

European Practices *L. D. Price*

Air Conditioning. *G. S. Jones, Jr.*

Canadian Wiring Systems and Appliances. *F. R. Whatmough*

Motors

Commercial Structure

9:00 a.m. Wire Communications

CP.* Dial Switching of Toll Circuits in Independent Telephone Company Areas—Transmission Considerations from the DDD Standpoint. *J. N. Petrie,* Automatic Electric Company

58-5. Nation-wide Switching of Intertoll Trunks—Transmission Considerations. *O. F. Wallman,* American Telephone and Telegraph Company

58-4. Impedance and Return Loss Performance of Telephone Plant in Metropolitan Areas. *L. B. Bogan,* American Telephone and Telegraph Company

58-214. Study of Return Losses on Loaded Trunk Cables and Methods Taken To Improve Them. *G. H. Speake,* Southern Bell Telephone & Telegraph Company

9:00 a.m. Production and Application of Light

9:00 a.m. Electrochemical Processes

CP58-169. An Evaluation of a High-Current Mechanical Rectifier. *J. C. Trackman,* Brown Boveri Corporation; *T. F. Ingate,* General Analine and Film Corporation; *H. Buetikofer,* Brown Boveri Corporation

CP.* A User's Experience with Rectifier Transformer Failures. *E. H. Coxe, H. O. Bourque,* Ethyl Corporation

CP.* A Planned Large Hi-Voltage Germanium Rectifier Installation. *R. P. Stratford, H. N. Hickok,* General Electric Company; *George Cohma,* Diamond Alkali Company

CP.* 3,000 Kw 300 Volt D-C Semiconductor Rectifier. *Otto Jenson,* I-T-E Circuit Breaker Company

58-170. Application of Semiconductor Power Rectifiers in Electrochemical Industry. *R. P. Stratford,* General Electric Company

9:00 a.m. Feedback Control Systems and Computing Devices

58-90. Statistical Design Theory for Digital Controlled Continuous Systems. *S. S. L. Chang,* New York University

58-91. The Effect of Quantization on Sampled-Feedback Systems. *J. E. Bertram*, Columbia University

CP.* Why Not Use Sine–Cosine and Encoder. *W. I. Frank*

CP.* Accuracy Limitation of Geared-Up Encoder. *W. Barr, W. I. Frank*

CP58-240. General Analysis and Stability Study of Finite Pulsed Feedback Systems. *G. Farmanfarma*, University of California

9:00 a.m. System Engineering

58-165. Penalty Factors from Power System Equations. *P. G. Lubisich*, Los Angeles Department of Water and Power

CP.* Some Applications of a New Approach to Loss Minimization in Electrical Utility Systems. *T. W. Sze, Jr., J. R. Garnett, J. F. Calvert*

58-104. Operating Experience with GEDA Automatic Economic Dispatching—Ohio Edison System. *R. H. Travers*, Ohio Edison Company

CP58-207. Operating Experience with West Penn Power's Economic Dispatch Computer. *W. R. Hamilton, W. H. Osterle*, West Penn Power Company

9:00 a.m. Rotating Machinery

58-157. A Basic Analysis of Synchronous Machines—I. *W. A. Lewis*, Illinois Institute of Technology

58-197. A Complete Equivalent Circuit of a Synchronous Machine. *I. Giaever*, General Electric Company

58-198. Measurement of Rotor Displacement Angle on Synchronous Machines. *V. A. Kinitsky*

9:00 a.m. Switchgear

58-127. 138-Kv Metal Enclosed Isolated Phase Bus and Switching Structure. *R. H. Albright*, I-T-E Circuit Breaker Company

58-128. Service Experience and Staged Field Tests on the 115-Kv 1,000,000-Kva Gas-Filled Power Circuit Breaker. *E. B. Henry*, Gulf Power Company; *R. E. Friedrich, F. L. Reese*, Westinghouse Electric Corporation

58-129. A New 46-Kv Low Capacity Circuit Breaker for Multiple Reclosing Duty. *R. N. Yeckley, R. H. Cunningham*, Westinghouse Electric Corporation

58-114. A 46-Kv Automatic Circuit Recloser. *E. J. Field*, I-T-E Circuit Breaker Company

9:00 a.m. Transmission and Distribution

58-14. Analytical Studies of Lightning Performance of One and Two Ground Wire 138-Kv Double Circuit Lines of the Commonwealth Edison Company. *E. T. B. Gross*, Illinois Institute of Technology; *R. W. Caswell, E. F. Koncel, Jr.*, Commonwealth Edison Company

58-24. The Lightning Stroke. *C. F. Wagner, A. R. Hileman*, Westinghouse Electric Corporation

CP58-189. Anomalous Flashovers on Transmission Lines—II. *C. J. Miller, Jr.*, Ohio Brass Company

CP.* Magnetic Fields Around a Transmission Line Tower. *J. G. Anderson, J. H. Hagenguth*, General Electric Company

CP.* Lightning Current Distribution in Towers and Ground Wires. *A. J. Schultz, I. B. Johnson*, General Electric Company; *W. S. Price*, American Gas and Electric Service Corporation

9:00 a.m. Transformers

58-112. Insulation Co-ordination of Gas Insulated Transformers. *G. Camilli, R. E. Coates*, General Electric Company

CP.* Insuldur—Another Milestone in Transformer Insulation Development. *J. G. Ford, J. Swiss, G. C. Gainor, M. G. Leonard*

58-155. Temperature Rise of Dry-Type Transformers. *A. A. Halacsy*, Delta-Star Electric Company

CP.* Further Considerations on Reduced Transformer Insulation Levels. *J. R. Meador*, General Electric Company

9:00 a.m. Radiation Effects on Dielectrics

CP.* Effects of Gamma Radiation on Silicone Dielectrics. *C. E. Currin*, Dow Corning Corporation

CP.* The Radiation Effects Information Center. *H. R. Batchelder, C. J. Lyons*, Battelle Memorial Institute

CP58-123. A Method for the Evaluation of Radiation Damage to the Mechanical Properties of Plastics. *J. H. Kleinpeter*, General Electric Company

CP.* The Effects of Gamma Radiation at High Temperatures on the Engineering Properties of Elastomer Materials. *P. W. Davis*, General Electric Company

CP.* Conductivity Induced in Insulating Materials during Gamma Irradiation. *G. C. Huth*, General Electric Company

9:00 a.m. Electrostatic Processes

CP.* A Probe Method for Measuring Potentials in Corona. *G. W. Penney, R. E. Matick*, Carnegie Institute of Technology

CP.* Field Strength Measurements in Parallel Plate Precipitators. *J. S. Lagarias*, Koppers Company

CP.* Automatic Precipitator Control. *L. L. Little*, Western Precipitation Corporation

CP.* Properties and Applications of High Energy Electrons. *J. C. Trump*, Massachusetts Institute of Technology

CP.* Laboratory and Field Testing on Silicon Diode Rectifiers for Electrical Precipitation Service. *H. D. Laube, L. J. Theriault*, General Electric Company

58-229. Automatic Control of Electrical Precipitation Rectifiers. *H. E. Van Hoesen, H. J. White, H. J. Hall*, Research-Cottrell Inc.

57-87. Some Measurements of Abnormal Corona. *G. W. Penney*, Carnegie Institute of Technology; *J. G. Hewitt*, International Business Machines Corporation

9:00 a.m. Computing Devices and Data Communications

CP.* F-M Digital Subset. *L. A. Weber*, Bell Telephone Laboratories

CP.* Synchronizing Clock for Data Transmission. *J. O. Edson, M. Flavin, A. D. Perry*, Bell Telephone Laboratories

CP.* Digital Data Transmission between Dissimilar Processing Centers. *J. A. Brustman, I. Cohen, H. P. Guerber*, Radio Corporation of America

2:00 p.m. Safety Symposium (continued from Thursday morning)

Canadian Utilities. *H. Hyde*
Electrical Inspection.
Underwriters' Labs, Inc. Requirements.
Major Appliances.
Utility Distribution.
Space Heating.
Army.
Navy Installations. *C. D. Friday*
Lighting Sources.
Panelboards.

2:00 p.m. Wire Communications

58-59. A Basis for Transmission Performance Objectives in a Telephone Communication System. *W. K. MacAdam*, American Telephone and Telegraph Company

CP58-236. The Planning of National Telecommunication Networks. *C. A. Parry*, Page Communications Engineers

CP.* Pretied Tie for Communication Line Wires. *C. R. Ballard*, Rural Electrification Administration; *R. R. Bouche*, National Bureau of Standards

58-239. A New Method of Frequency Error Correction in Carrier Systems. *B. R. Stachiewicz*, Federal Telecommunication Laboratories (Re-presented for discussion only)

57-907. A Transistorized Repeater for Use with the 45 BN Cable Carrier System. *V. Babin, R. Fish*, Lenkurt Electric Company

58-215. A Frequency-Converting Telephone Carrier Repeater for Military Use. *G. Goltsos, J. H. Johnston*, Signal Corps Engineering Laboratory; *R. B. Anderson*, Lenkurt Electric Company (Re-presented for discussion only)

2:00 p.m. Communication Switching Systems

CP.* A New Teleprinter Switching System with Motor-Driven Selectors (TWN). *E. Rossberg*, Siemens & Halske A.G.

CP.* An Automatic Communications Switching System. *J. A. Brustman, I. Cohen, L. S. Levy*, Radio Corporation of America

CP* STRAD—A New Concept for a Fully Electronic Automatic Signal Sorting and Distribution System. *E. P. G. Wright*, Standard Telecommunication Laboratories, Ltd.

CP.* Communication Networks for Coded Information. *J. M. Unk*, N. V. Philips' Telecommunicatie Industrie

2:00 p.m. Symposium: Metering of High Current Low Voltage D-C Power Systems

CP.* *J. H. Miller* Weston Electrical Instrument Corporation

CP.* *G. B. Scheer*, Kaiser Engineers

CP.* *L. H. Wolgast*, Reynolds Metals Company

CP.* *A. F. Touchette*, General Electric Company

CP.* *M. E. Reagan*, Westinghouse Electric Corporation

CP.* *Max Kramer*, Aluminum Company of America

CP.* *F. Langvee*, Aluminum Company of Canada, Ltd.

2:00 p.m. Transistors in Feedback Control Systems

CP58-87. Some Stability Considerations in the Design of Large Feedback Junction Transistor Amplifiers. *Herbert Hellerman*, University of Delaware

CP58-88. Silicon Transistor Performance in a Chopper Application. *C. C. Thompson, J. Giorgis, Jr.*, General Electric Company

CP58-89. Application of Switching Transistors and Saturable Reactors in a High-Performance Servo. *F. B. Cox, P. R. Johannessen*, Massachusetts Institute of Technology

CP58-92. Compensating Saturation in Feedback Control Systems by Excess Error Storage. *S. S. L. Chang, R. W. Archbald*, New York University

CP.* Preliminary Report of Feedback Control Systems Subcommittee on Component Specifications. Chairman, *D. D. Pidhayny*

2:00 p.m. System Engineering and Power Generation.

58-113. The Criterion of Economic Choice. *P. H. Jeynes, L. Van Nimwegen,* Public Service Electric and Gas Company

58-166. Valve Point Loading of Turbines. *G. L. Decker, A. D. Brooks,* Dow Chemical Company

CP58-167. Performance Computer for Steam–Electric Generating Units—Part I. *A. J. Hornfeck, T. S. Imsland,* Bailey Meter Company

CP58-168. Evaluation of Combustion Control-Load Control Tie-in Equipment at Niles Station of Ohio Edison Company. *R. H. Travers, D. B. Zelenka,* Ohio Edison Company; *H. A. List, C. Nichols,* Leeds and Northrup Company

2:00 p.m. Rotating Machinery

58-199. An Advanced Concept for Turbine–Generator Stator Winding Insulation. *E. J. Flynn, C. D. Richardson, C. E. Kilbourne,* General Electric Company

CP58-203. Medium Voltage A-C Testing of Rotating Machinery Insulation. *F. S. Oliver,* Doble Engineering Company

CP58-204. Separation of Absorption and Leakage Components in High Voltage D-C Insulation Testing. *F. R. Schleif, L. R. Engvall,* Bureau of Reclamation

2:00 p.m. Switchgear

CP.* A 1,000-Mva, 13.8-Kv Magnetic De-ion Air Circuit Breaker. *R. C. Dickinson, Russell Frink,* Westinghouse Electric Corporation

CP58-130. A Magnetic Air Circuit Breaker for 350 Mva, 3,000 Amperes and 4.16 Kv. *Russell Frink, J. M. Kozlovic,* Westinghouse Electric Corporation

CP58-249. 13.8-Kv Metal-Clad Switchgear with 5-Cycle Magnetic Air Circuit Breakers Having Symmetrical Interrupting Ratings. *E. B. Rietz, P. G. Smith, W. A. Carter,* I-T-E Circuit Breaker Company

58-43. A New Design Metal-Clad Switchgear for 4.16-Kv Service. *N. Kreekon, W. H. Lane,* Allis-Chalmers Manufacturing Company

CP58-248. A New Magnetic Air Circuit Breaker for 2.3/4.16-Kv Service. *M. J. Reilly, V. A. Mortenson,* Allis-Chalmers Manufacturing Company

2:00 p.m. Transmission and Distribution

58-176. Arc Drop during Transition from Spark Discharge to Arc. *C. F. Wagner, C. M. Lane, C. M. Lear,* Westinghouse Electric Corporation

58-22. The Insulator Contamination Problem as Influenced by Silicone Surface Coatings. *J. E. Conner,* Southern California Edison Company; *A. D. Lantz, Jr.,* Ohio Brass Company

58-57. Development of Corona Shields for Suspension Assemblies of Bundled Conductor Transmission Lines. *J. Kaminski, Jr.,* General Electric Company

CP.* Radio Influence Voltages Caused by Point Protrusions on Bundle Conductors. *T. W. Liao, P. A. Doyle,* General Electric Company

CP.* A Comparative Study of the Radio Influence Characteristics of Several High-Voltage Transmission Lines. *W. S. Price,* American Gas and Electric Service Corporation; *C. Concordia, G. E. Adams,* General Electric Company

2:00 p.m. Transformers

58-153. Effect of Coil Winding and Processing on the Electric Strength of Class OA Insulating Materials. *W. T. Sackett, Jr.,* Kuhlman Electric Company

58-109. Economics of Design and Application of Transformers. *E. C. Wentz, N. Chackan,* Westinghouse Electric Corporation

CP.* A Medium Size Anechoic Chamber. *T. J. Twomey*

CP58-156. The Technical Assistant Can Be an Aid to the Engineer. *G. R. Monroe,* Westinghouse Electric Corporation

58-46. Coil Construction for Current Limiting Reactors. *L. E. Sauer,* Westinghouse Electric Corporation

2:00 p.m. Solid-State Dielectric Devices—Electroluminor and Photoconductor Devices

58-150. An Electroluminescent Digital Indicator with ELPAK Translation Logic. *E. A. Sack,* Westinghouse Electric Corporation

CP.* Gain-Bandwith Limitations of Photoconductors. *A. Rose,* Radio Corporation of America Laboratories

CP.* Gains, Response Times, and Traps in Powder Photoconductors. *H. B. DeVore,* Radio Corporation of America Laboratories

CP.* Information Display Panels Utilizing Electroluminescent and Photoconductive Materials. *D. B. Barker, W. L. Gardner,* Massachusetts Institute of Technology Lincoln Laboratories

CP58-151. New Electroluminescent Devices for Forming and Holding Images. *K. Butler, F. Koury,* Sylvania Electric Products Inc.

2:00 p.m. Computing Devices and Research—Thinking Machines of the Future

CP.* *J. B. Wiesner,* Massachusetts Institute of Technology

CP.* The Future Matching of Man and Machine. *Simon Ramo,* Ramo-Wooldridge Corporation

CP.* *C. R. De Carlo,* International Business Machines Corporation

2:00 p.m. Heavy Traction

CP58-237. Some Aspects of the Application of Diesel–Electric Locomotives in North and South America. *G. T. Bevan,* General Electric Company

CP.* Nondestructive D-C High-Potential Testing of Insulation Systems in Low- and Medium-Voltage D-C Equipment. *A. M. Odok,* General Electric Company

58-238. Mobile Reflectoscopic Inspection of Railroad Car Axles on the Chesapeake and Ohio Railway. *E. R. Hauer,* Chesapeake and Ohio Railway Company; *C. M. Angel*

Friday, February 7

9:00 a.m. Telegraph and Data Communications Systems

58-2. Error Checking for Five-Channel Telegraphic Tape. *R. A. Barbeau,* International Business Machines Corporation

CP.* Teledata System. *E. O. Blodgett,* Friden Calculating Machine Company

58-172. Data Transmission Testing Set. *J. E. Boughtwood,* Western Union Telegraph Company

CP.* Recorded Carrier System. *R. M. Gryb,* Bell Telephone Laboratories

9:00 a.m. Cathodic Protection

CP58-58. The Canso Causeway. *T. R. B. Watson,* Corrosion Service Ltd.

CP58-95. Cathodic Protection of Underground Plant Facilities. *H. W. Hosford,* Harco Corporation

CP.* Effective Voltage on Cable Jackets and Analysis. *G. H. Hunt,* Simplex Wire and Cable Company

9:00 a.m. Feedback Control Systems

58-10. A Nonlinear Integrator for Servomechanisms. *J. C. Clegg,* University of Utah

58-12. Transfer Function of Two-Phase Servomotors. *S. L. Mikhail,* University of California; *G. H. Fett,* University of Illinois

58-84. Obtaining the Frequency Response Characteristics of a Nonlinear Servomechanism from an Amplitude- and Frequency-Sensitive Describing Function. *W. A. Stein, G. J. Thaler,* U.S. Naval Postgraduate School

58-85. Approximate Analysis of the Drag Cup A-C Tachometer. *L. A. Knox,* International Business Machines Corporation.

58-86. An Analysis of a Servomechanism with Backlash by the Ritz-Galerkin Method. *Katsuhiko Ogata,* University of Minnesota; *C. P. Atkinson,* University of California

9:00 a.m. Rotating Machinery

CP.* Water Cooling of Generator Stator Windings. *G. V. Browning, J. F. Quiland, C. H. Holley,* General Electric Company

58-148. Harmonics of the Salient Pole Synchronous Machine and Their Effects—Part III—The Differential Leakage of the Damper Winding with Respect to the Main Wave Current Distribution in the Damper Bars.

CP58-149. Functional Evaluation of Two D-C Form-Wound Rotor Coil Insulation Systems Using a Test Formette. *E. S. Yates,* General Electric Company

57-171. Evolution of the Design and Operation of Large Thrust Bearings. *R. A. Baudry,* Westinghouse Electric Corporation

9:00 a.m. Transmission and Distribution

CP58-191. The Resistance and Reactance of Aluminum Conductors, Steel Reinforced. *W. A. Lewis,* Illinois Institute of Technology; *P. D. Tuttle,* Alcoa Research Laboratories

CP.* Magnetic Properties of ACSR Core Wire. *L. W. Matsch,* University of Arizona; *W. A. Lewis,* Illinois Institute of Technology

58-41. Current-Carrying Capacity of ACSR. *H. E. House, P. D. Tuttle,* Alcoa Research Laboratories

CP.* Kemano–Kitimat 300-Kv Cross Suspension System. *H. B. White,* Aluminum Company of Canada, Ltd.

9:00 a.m. Transformers

58-54. Line-Drop Compensator Settings for Automatic Parallel Operation of Load-Tap Changing Transformers. *S. Minneci, H. E. Pinney,* General Electric Company

58-158. Measurement of Iron and Copper Losses in Transformers. *T. R. Specht, L. B. Rademacher, H. R. Moore,* Westinghouse Electric Corporation

58-152. A Transistorized Bushing Potential Device. *R. L. Stauffer,* Canadian Westinghouse Co. Ltd., *E. O. Shepard,* Westinghouse Electric Corporation

58-159. An Improved Method of Oil Preservation and Its Effect on Gas Evolution. *W. J. Degnan, G. G. Doucette, Jr., R. J. Ringlee,* General Electric Company

58-55. Thermal Analysis of Transformer Load Cycles. *S. Bennon,* Westinghouse Electric Corporation

9:00 a.m. Semiconductors

CP.* Thermoelectric Heat Pumping—A Sur-

vey. *N. E. Lindenblad*, Radio Corporation of America Laboratories

CP.* A Survey of Thermoelectric Power Generation. *W. J. van der Grinten, P. H. Klein*, General Electric Company

CP.* Practical Thermoelectric Power Generation. *S. J. Angello*, Westinghouse Research Laboratories

CP58-186. A One-Watt Solar Power Plant. *D. H. Smith*, Bell Telephone Laboratories

9:00 a.m. Electrical Techniques in Medicine and Biology

CP.* A Survey of Imaging Devices Suitable for Medical Purposes. *Joseph Lempart*, Westinghouse Electric Corporation

CP.* Density Stabilization System for X-ray Cine-Fluoroscopy. *P. A. Duffy*, Westinghouse Electric Corporation

CP.* Electronic Capsule in Gastrointestinal Investigation. *J. T. Farrar, M.D., Cornell University; W. J. Bieganski*, Radio Corporation of America; *C. Berkeley*, Rockefeller Institute

CP.* Square-Wave Electromagnetic Flowmeter for the Measurement of Mean and Phasic Flow in Unopened Blood Vessels. *M. D. Spencer, M.D.*, Bowman Gray School of Medicine; *E. J. Dennard*, Western Electric Company

CP.* Rectilinear Co-ordinate Injection Control of Dual Reagents for Chromatographic Columns. *G. C. Riggle*, National Institutes of Health

CP58-97. Some Applications of Air Ion Measurement. *J. C. Beckett*, Wesix Electric Heater Company

9:00 a.m. Computing in the IGY

CP.* Vanguard Satellite Launching Vehicle. *D. D. Pasik, E. E. Loft, W. A. Elfers*, Martin Company

CP.* Computational Problems Associated with the Vanguard IGY Satellite Program. *J. W. Siry*, Naval Research Laboratories

CP.* Role of the MIT Computing Center in Visual Tracking of Earth Satellite. *J. F. Blackburn*, International Business Machines Corporation

CP.* Tracking of Earth Satellites at the Vanguard Computing Center. *A. R. Mowlem*, International Business Machines Corporation

9:00 a.m. Computers

58-190. Train Performance and Locomotive Tonnage Ratings Calculated by Digital Computer. *J. E. Hogan*, Pennsylvania Railroad Company

CP.* A Digital Computer Program for Multiple Unit Train Performance Calculations. *R. E. Stillwagon, C. P. Saalback*, Westinghouse Electric Corporation

CP.* The Application of Computers to Problems of Transportation Equipment Design. *D. R. MacLeod*, General Electric Company

9:00 a.m. Engineering Education in Foreign Lands

CP.* Technical Education in India. *M. G. Malti*, Cornell University

CP.* Engineering Education in Central Europe. *W. F. Gauster*, Oak Ridge National Laboratory

CP.* Technical Education in England. *Denys Akhurst*, Massachusetts Institute of Technology

CP58-147. Electrical Engineering Education and Research in the USSR. *P. A. Abetti, G. F. Lincks*, General Electric Company

Courtesy of Bethlehem Steel Company

THE HOBOKEN YARD, Shipbuilding Division, Bethlehem Steel Company, advantageously situated on the New Jersey side close to the North River Piers, is one of the largest and most modern and efficient repair yards in the nation. The yard will be visited during a Wednesday morning Winter General Meeting inspection trip.

2:00 p.m. Telegraph Systems

58-44. An Improved Six-Channel Time Division Multiplex for Submarine Cable Telegraphy. *H. F. Wilder*, Western Union Telegraph Company

58-45. Automatic Telegraph Switching System Plan 55-A. *G. S. Vernam*, Western Union Telegraph Company

CP.* Teletypewriter Error Checking System. *A. L. Whitman*, Bell Telephone Laboratories

CP.* Some Recent Western Union Developments in Printing Telegraph Apparatus. *F. W. Smith*, Western Union Telegraph Company

2:00 p.m. Storage Batteries

2:00 p.m. Feedback Control Systems

58-80. The Sensitivity of the Poles of a Linear, Closed-Loop System. *R. Y. Huang*, Curtiss-Wright Corporation

58-81. Limiting Values of Driving Point Impedances and Transfer Functions Due to Component Variations. *Sheldon Jones*, Hughes Aircraft Company

CP58-13. Gain Variations in an Output Rate Stabilized Servomechanism. *E. G. Trunk*, Servo Corporation of America

58-82. Time-Varying Analysis of a Guidance System. *B. Friedland*, Columbia University

58-83. Use of Phase Space in Transient Stability Studies. *S. T. Bow*, Chinese Academy of Science; *J. E. Van Ness*, Northwestern University

2:00 p.m. Rotating Machinery

CP58-205. A Brush Manufacturer Looks at Silicone Insulation. *H. E. Campbell, R. T. Lundy, J. D. Snyder*, General Electric Company

CP58-200. Axial Vibration and Noise in Ball Bearing Motors. *E. G. Fischer*, Westinghouse Electric Corporation

CP58-201. Applications of Electromagnetic Field Theory to Induction Machines. *E. C. Guilford, R. M. Saunders*, University of California

CP58-206. Theory of Electromechanical Energy Converters. *E. C. Guilford, R. M. Saunders*, University of California

2:00 p.m. Transmission and Distribution

58-30. The Economics of Subtransmission Planning. *D. N. Reps*, Westinghouse Electric Corporation

58-23. Evaluation of Distribution Systems for Medium Load Density Commercial Areas. *G. L. Landgren*, Commonwealth Edison Company

58-174. A Protection Plan for Distribution Feeders. *J. R. Hayden, J. E. Martin, R. L. Tilson*, Public Service Company of Colorado

2:00 p.m. Computers in Design

58-162. The Practice and the Economics of Applying Digital Computers to Engineering Problems. *P. A. Abetti, S. B. Williams*, General Electric Company

58-233. Philosophy of Applying Digital Computers to the Design of Electrical Apparatus. *P. A. Abetti, W. J. Cuthbertson, S. B. Williams*, General Electric Company

CP58-234. A Generalized Computer Procedure for the Design of Optimum Systems—Part I. *R. R. Brown*, Massachusetts Institute of Technology

CP58-235. A Generalized Computer Procedure for the Design of Optimum Systems—Part II. *R. R. Brown*, Massachusetts Institute of Technology

2:00 p.m. Data Communications

CP.* SAGE Data System Considerations. *R. G. Enticknap*, Lincoln Labs.; *E. F. Schuster*, Western Electric Company

CP.* SAGE Data Terminals. *R. S. Soffel, E. G. Spack*, Bell Telephone Laboratories

CP.* Communication Channels for SAGE DATA System. *R. T. James*, American Telephone and Telegraph Company

CP.* Methods of Evaluating the Performance of the *AI* Digital Data System. *A. E. Ruppel*, Bell Telephone Laboratories

2:00 p.m. Railroad Electrification

58-32. The Financial Return of Railway Electrification, an Approximate Method for Its

Determination. *H. F. Brown, H. E. Marmaros,* Gibbs and Hill Inc.

2:00 p.m. Switchgear

58-21. Suppression of Leakage Flux in Magnetic Air Breakers. *A. P. Strom,* Westinghouse Electric Corporation

CP.* A New Design of Low Voltage Power Circuit Breakers. *L. L. Baird, R. J. Baskerville,* General Electric Company

CP58-131. High Capacity Current Limiting Fuses Today. *E. M. Fitzgerald, V. N. Stewart,* General Electric Company

CP58-6. A New 2½ Cycle Recloser—Its Application on Today's Electric Distribution System. *W. C. Wiechmann,* McGraw-Edison Company

2:00 p.m. Industrial Control

CP.* The Application Static Switching Techniques to Programming Control. *M. W. Cannon, K. R. Thompson,* General Electric Company

CP.* Inductrol D-C Drives. *Max Berman,* General Electric Company

CP58-212. A Seven Times Magnetic Frequency Multiplier. *R. A. Stewart,* Westinghouse Electric Corporation

58-213. A Static Exciter for Aircraft A-C Generators. *H. H. Britten, D. L. Plette,* General Electric Company (Re-presented by title only)

58-138. An Electrohydraulic Speed and Load Division Control for Constant Speed Air Turbine Drives. *P. Dantowitz, L. G. Norris,* General Electric Company (Re-presented by title only)

TOD Forum To Be Held at Winter General Meeting

The 17th Forum of Technical Committee chairmen, vice-chairmen, and other members of the Technical Operations Department (TOD) will be held in connection with the AIEE Winter General Meeting at the Hotel Statler, New York, N. Y., on the evening of February 5, 1958.

The topics scheduled for discussion are immediately related to effective technical operations: maximum utilization of the AIEE organization; optimum handling of committee appointments for the 1958-59 year; the new emphasis on Special Technical Conferences; improvements in the processing, review, and evaluation of technical papers; and progress in the formation and integration of technical groups within the Sections.

ECPD-EJC Joint Assembly and 25th Annual Meeting of ECPD

THE JOINT ASSEMBLY of Engineers' Council for Professional Development (ECPD) and Engineers Joint Council (EJC) was held October 24-25, 1957, in the Hotel Statler, New York, N. Y. Four panel sessions on the subjects of the attitude survey, the community college of technological education, the place of the engineer in management, and new dimensions in post graduate education for the young engineer were held during the two-day Assembly, as well as two luncheon meetings and the Silver Anniversary Dinner commemorating the 25th Anniversary of ECPD. Meetings of the Council and its committees were held in parallel with the Assembly program.

Opening Meeting

The 25th Annual Meeting of ECPD was called together by President M. D. Hooven, who outlined the joint program and stated that since there were representations from many societies and disciplines, a certain amount of co-operation was required. The president's report brought out the support and help received from voluntary individual services not necessarily encompassed within the eight bodies of the formal organization. He stated that this constituted a demonstration of the unity and solidarity of people working together to further the interests of the profession.

Thorndike Saville, a past-president of ECPD as well as EJC, commented on how well the two organizations work together by defining areas with less overlapping of interests and by regional collaboration.

Silver Anniversary Dinner

The feature of the meeting was an address, "The Builders of Engineers' Council for Professional Development" by C. E. Davies, secretary of the American Society of Mechanical Engineers (ASME) and the first secretary of ECPD and of EJC. Speaking from the background of 38 years of professional service, Col. Davies outlined the chain of events beginning with the early work of William E. Wickenden and Charles F. Scott and the role of the ASME which led up to the Conference on Certification, invitations to other societies to participate, and the adoption of an ECPD charter in 1933. The work of the chairmen of each committee—Guidance, Student Development, Training, and Recognition—was documented up to Mr. Saville's leadership of the United States delegation to the Third EUSEC Conference and the proposed survey of the entire engineering profession. Col. Davies commented on the achievements, the financing, and the shortcomings of ECPD and suggested ways of attaining the objectives of the organization. The complete address is published on pages 50-52 of this issue.

President Hooven, who was toastmaster, drew attention to the broad representation from every society in the United States and Canada, which represented over one-half million engineers and demonstrated the unity and co-operation of the profession. Guests of honor, including past-presidents and officers of ECPD and EJC and representatives of the various constituent societies, were introduced.

Luncheon Meetings

The highlight of the first luncheon, held October 24, was a report of the Third EUSEC Conference on Engineering Education and Training presented by Mr. Saville, chairman of the United States delegation to the conference. The speaker explained the scope of the report, the procedures followed in preparing it, and the surmounting of difficulties when drawing comparisons between 12 countries having different languages, terminology, and educational systems. For example, the Hochschule in Germany is quite different from comparative educational institutions in the United States, and considering post-graduate education, the practice in Great Britain and the United States differs greatly from that in the other countries. Tribute was paid to Dr. Maver of Holland who prepared flow charts which gave the U. S. delegation the best picture. When

C. E. DAVIES, secretary of the American Society of Mechanical Engineers, was the principal speaker at the Silver Anniversary Dinner of Engineers' Council for Professional Development, held at the Hotel Statler, New York, N. Y.

completed, the report also will contain a glossary to elucidate unfamiliar terms.

Speaking about the criteria for professional recognition, Mr. Saville explained that in most European countries, graduates of universities are recognized by law. In Great Britain, recognition is by charter membership of one of the three great societies. Recognition in other countries is by title, Diploma Engineer; whereas in the United States recognition is by license. The delegation headed by Mr. Saville, which included H. H. Armsby, M. M. Boring, and H. L. Hazen, represented for the first time a concentrated direct drive to present United States views on education. The Third EUSEC Conference on Engineering Education and Training made a great contribution to education internationally and to a better world understanding.

After the presentation of the report, O. V. Schier, deputy secretary of the ASME, who attended the conference as an observer, stated that it was a real thrill to see the reactions which the United States delegation had brought about. France was complimented on having made excellent arrangements which included a good translation service and well-spent reception time. Mr. Schier said that he was looking forward to the next meeting to provide them with the same courtesies.

Col. L. F. Grant, who acted as toastmaster, concluded with the remark that he was looking forward to the publication of the report by the British, which would be of great benefit to all engineering education.

The feature of the second luncheon held on October 25 was an address, "The Role of the Engineering Colleges in Professional and Engineering Development" by Dean Dana Young of Yale University. Attention was drawn to today's changing trends which are swift and complex with resulting changes in the character and functions of the profession. The speaker highlighted the trends in engineering education and their effects upon industry. The greater emphasis on basic theory and less on engineering know-how will require industries to provide advanced specialized training. The introduction of the social sciences in the engineering curriculums will grow and will lessen the gap between technical knowledge and the more liberalized form of education. The speaker pointed out that there is an increase in the number taking graduate work and major emphasis will be on training in basic theory and research. He stated that industry must provide advanced training in these rapidly expanding fields and the engineering profession must recognize that education is a lifetime job. Engineering education should not be thought of as training men for industry but as the training of a man's individual power. The changes in the educational pattern are as inevitable as the changes in industry itself.

In the absence of J. W. Barker, president of EJC, T. H. Chilton acted as toastmaster and introduced the speaker.

The Attitude Survey

Four papers were presented during a panel on the attitude survey with Dr. Hugh Dryden, director, National Advisory Committee for Aeronautics, presiding.

The first paper presented the attitudes and motivations of scientists and engineers toward their jobs obtained from an attitude survey of scientists and engineers in Government and industry conducted by the White House Committee on Scientists and Engineers for Federal Government Programs. The presentation, which was made by A. F. Siepert, explained that there were 17,439 respondents from Government agencies and 3,317 respondents from private laboratories which afforded an opportunity for a comparison of attitudes. The comparison of Government attitudes with industry was very similar on most points; however, Government agencies are much behind industry in pay scales and prospects for salary advancement. The fringe benefits of Government employment, such as vacations, sick leave, job security, retirement system, and so forth, were considered much better.

The second paper in the panel, by Winston Oberg, associate professor of management at Michigan State University and formerly a personnel assistant at Esso dealt with an action program for industry developed as a result of the findings from the White House Committee survey. Prof. Oberg informally polled five companies participating in the survey and summarized the results as follows: (1) the survey was worth while; (2) it caused most company management some surprises; and (3) the survey has not yet been completely digested and acted on in any of the participating companies.

The third paper, presented by Dr. Joseph Colmen, a psychologist and chief of the Personnel Research Branch, Headquarters U. S. Air Force, described an action program for the Government. It was stated that the Government would take proper action through legislation to provide greater flexibility and better starting salaries for graduates as well as higher pay for those in the $12,000 bracket and above. Supervision and management were covered and it was reported that the National Bureau of Standards has set up advisory committees. The U. S. Air Force is conducting training on how to communicate, and special cash and honorary awards will be provided. Legislation is supported to permit training in the colleges at the graduate and postgraduate levels and ways will be found to permit travel to attend meetings. Prestige was given impetus when President Eisenhower directed the Civil Service Commission to disseminate knowledge of opportunities. It was pointed out that the coming picture for scientists and engineers in Government employ looks hopeful. The need to take action and improve conditions has been seen.

The last paper on the panel, given by C. W. Randle, partner and director of Management Research, Booz, Allen & Hamilton, dealt with the question of whether the word really gets through. In a survey of some 3,500 research and laboratories employees, the speaker pointed out that management must be aware of problems in the laboratory and their order of magnitude as well as the need for good two-way communication between management and laboratory people. When an attitude survey is made, employees should first know what management has in mind, the results should be made known, and the conditions rectified.

Community College and Technological Education

A panel of three speakers with J. W. Parker, past-president of ECPD, presiding, presented various aspects of the community college and technological education. In opening the session, the chairman stated that he refused to get excited about the short supply of engineering manpower. The demand will make itself felt and by natural processes enough men ultimately will be found. He stated that it was natural that there was a state of confusion in a democracy.

The first speaker on the panel, Dr. E. K. Fretwell, Jr., who is assistant commissioner for Higher Education in the State of New York, outlined the advantages of the two-year types of community colleges, their continuous growth, and stated that the junior college was deserving of considerably more credit. Some 16% more high school graduates would attend the two-year programs if facilities were available and some 73,000 spaces would be required for the program. In conclusion, he stated that more comprehensive planning was needed for both the two-year and four-year colleges on a state-wide and regional basis. Better guidance should be started in the secondary schools and additional financial assistance will be required. Co-operative relationships with business and industry also should be established. The two-year college is already providing a good service to industries.

The second speaker, Dr. Otto Klitgord, president, New York City Community College of Applied Arts and Sciences, Brooklyn, N. Y., outlined the programs and objectives of the two-year community colleges in the education of engineering technicians, pre-engineers, and engineers. Attention was drawn to Dr. Fretwell's remarks in connection with the creation of new two-year programs in existing local four-year colleges which would permit an increasing number of youths to acquire a good part of their higher education and still live at home. He believed that the faculties of all two-year colleges should do everything in their power to see that individuals having abilities enabling them to succeed as engineers are referred to the engineering colleges as soon as their abilities are detected. Conversely, belief was expressed that it was the responsibility of the faculties of the engineering colleges to assist those who do not succeed in their curriculums to seek transfer into a technical terminal program.

The third speaker, G. R. Henninger, associate director, Engineering Extension, Iowa State College and director of the National Survey of Technical Institute Education of the American Society for Engineering Education (ASEE), laid down some carefully considered definitions for the engineering technician which distinguished him from the professional engineer or scientist on the one hand and the skilled craftsman on the other hand. He referred to the engineering manpower team as a three-part team made up of the engineer, the engineering technician, and the craftsman proportionate to the task to be undertaken. To produce this three-part team efficiently requires a three-part educational program: (1) university collegiate program for engineers and scientists,

(2) technical institute types of engineering program for engineering technicians, and (3) vocational trade programs for the craftsman. In conclusion, he stated that the field of the engineering technician is a segment of the over-all spectrum of engineering manpower and, for optimum development of the engineering technician, the technical institute type curriculums as embraced in the technical institute accrediting program of ECPD is considered to be the most effective and, hence, the most desirable educational program. Collectively, the community college, with 635 such institutions established and operating across the country, is in a position of strategic importance and potential with respect to the expanding need for educational capacity in the semiprofessional zones of engineering and other technologies.

Place of the Engineer in Management

Four papers were presented in a panel under the chairmanship of H. F. Smiddy who drew attention to the fact that the papers represented a cross section of industry inasmuch as two of the speakers on the panel were from small industrial organizations and two from large organizations.

The first paper dealt with the place of the engineer in industrial management and was presented by F. W. Miller, president and director, Yarnall-Waring Company. In order to determine the qualifications of engineers to fill management positions, the speaker had canvassed 10 small industrial companies and found that 60% to 80% of the executive and managerial positions were filled by engineers. The additional areas which engineers should add to their knowledge in order to become effective managers were outlined as well as places where the training and experience can be acquired. Examples of management functions in finance, the balancing of industrial production to insure internal and customer satisfaction, and the assignment of responsibilities were outlined.

The second paper by W. E. Mullestein, vice-president of the Lukens Steel Company, described the on-the-job training of engineers in industrial management in one of the world's largest steel plate companies. The engineer with education, experience, and leadership qualifications is sought out for the management team. Movement over a two-year period from department to department is a matter of work assignment, staff, or line, developed in accordance with the individual's known interests and abilities. Lukens also helps young engineers who wish to broaden their backgrounds through attendance at night school or through correspondence courses which are paid for by the company upon satisfactory completion of the assigned work.

The next speaker on the panel, Harry Kreiger, Jr., administrator, engineering–personal relations, Radio Corporation of America, outlined the training programs in a large organization for management selection and development which consisted of a program for first level supervisors of engineers, middle management training, and advanced management training. Mr. Krieger pointed out that much of the training needs of engineers headed for management and those who have no plans to move into management are similar; hence they have a specialized training program and a program for new engineers for training in nonsupervisory positions.

The last speaker, R. G. Ernest, head of the technical department, Bayonne Refinery, Esso Standard Oil Company, stressed the importance of the management climate and the basic management principles. Management climate involves a recognition that human assets are far more important than raw material reserves, new equipment, or financial strength. There must be a deep-rooted conviction and understanding that people not things spell success for an organization. Six basic principles of management were outlined as delegating responsibility, assuming responsibility, facing up to problems, challenging jobs, high standards of performance, and the encouragement of personal initiative. Aiming toward developing each individual to the maximum of his capabilities, steps were outlined to evaluate and develop these basic management principles.

Trends in Postgraduate Education

New trends in combining advanced engineering education with engineering employment were discussed in a panel with Dr. Ernst Weber, acting president, Polytechnic Institute of Brooklyn, presiding.

The first speaker, Dean Paul Hemke of Rensselaer Polytechnic Institute, described a unique off-the-campus center established in the vicinity of Hartford where graduate programs for full-time employees leading to the master's degree, with majors in science and engineering, are conducted. The building and land were given outright to Rensselaer Polytechnic Institute and the United Aircraft Corporation underwrites the operational budget for a five-year period. A tuition assistance plan is followed whereby the employee-student pays $20 per credit hour at registration, one half of which is refunded upon satisfactory completion of the course, and the remainder of the deposit returned upon completion of the degree program. Sympathetic and co-operative viewpoints were obtained from the two state departments of education as well as corporation officials.

The second speaker, Dr. S. B. Ingram, director of education and training, Bell Telephone Laboratories, Inc., described the integration of the communications development training program with the College of Engineering of New York University. Faculty is provided by the university and the curriculums necessary to obtain the graduate degree prescribed by them, but the work is done on company time. This is a company assignment for all new college graduate recruits to the technical staff at the B.S. and M.S. level. If course requirements fall outside of the requirements for the company's training program, the employee takes these courses under a graduate-study tuition-refund plan, after working hours. Graduate study at the New York University Center is only one of three phases of the communications development training program which also offers a series of training courses in the special technology required and taught by the Bell System which carry no graduate credit.

The third speaker, R. W. Rawson, chief engineer of the Fansteel Metallurgical Corporation, outlined the company's special requirements and arrangements for the development of engineers co-operatively with Northwestern University and the Illinois Institute of Technology. Fansteel also has a postgraduate program including a curriculum in Lake Forest College known as the Industrial Management Institute and supervisors have been sent to Harvard Business School and the University of Chicago for special training in management.

The last speaker on the panel, F. L. Martinson, chief engineer, Electronics Associates, Inc., outlined a broad company policy to reimburse the employee 100% of all tuition fees for courses relating to his field and successfully completed. The clause, "relating to his field," is very liberally interpreted and allows the employee to take any course which will permit him to do a better job within the company. Arrangements for undergraduate work are with Monmouth College and graduate students usually attend Rutgers University, Newark College of Engineering, or one of the other graduate schools in the New York metropolitan area. Additional education may be obtained on a full-time basis with a leave of absence with provision for continuation of fringe benefits and seniority after return of the employee.

The Proceedings of the symposium may be obtained, when available, from EJC or ECPD, 33 W. 39th St., New York 18, N. Y. For all who attended the ECPD-EJC Joint Assembly, the Proceedings cost was part of the registration fee.

Nominating Committee Will Meet February 3, 1958

The AIEE Nominating Committee will meet in the Boston Room, Hotel Statler, New York, N.Y., 9:00 a.m., February 3, 1958, during the Winter General Meeting of the Institute, to nominate candidates for AIEE offices to be voted on by the membership in the spring of 1958. (See Constitution C30, 31, 32, 33; Bylaws B27, 28; and *Electrical Engineering* November 1957, p. 1006-7.) Representatives receive travel allowance. Alternates are required to attend only if called upon to serve in place of their representative. Members of the committee are as follows:

Representing the 12 geographical Districts:

1. E. M. Morecock, Rochester Institute of Technology, 65 Plymouth Ave., Rochester, N.Y.
2. Hendley Blackmon, Westinghouse Electric Corp., P.O. Box 2278, 3 Gateway Center, Pittsburgh 30, Pa.
3. R. W. Gillette, Consolidated Edison Co. of N.Y., Inc., 4 Irving Place, New York 3, N.Y.
4. W. J. Miller, University of Alabama, University, Ala.
5. W. M. Ballenger, General Electric Company, 840 S. Canal St., Chicago 80, Ill.
6. Max Mattison, Nebraska Public Power System, Columbus, Nebr.
7. H. R. Vaughan, Westinghouse Electric Corp., 101 West 11th St., Kansas City 6, Mo.

8. E. B. Love, 3440 Sterne St., San Diego 6, Calif.
9. M. D. Duffy, Pacific Power & Light Co., 920 S.W. Sixth Ave., Portland 4, Oreg.
10. B. G. Ballard, National Research Council, Sussex St., Ottawa, Ont., Canada
11. J. W. Rittenhouse, Hi-Voltage Equipment Div., Joslyn Mfg. & Supply Corp., 4000 East 116th St., Cleveland, Ohio.
12. F. S. Bacon, Box 58, Winchester, Mass.

Alternates for District Representatives:

1. C. J. Fitch, International Business Machines Corp., Endicott, N.Y.
2. S. R. Warren, Jr., Towne Bldg., Room 109, 220 South 33rd St., Philadelphia 4, Pa.
3. W. T. Rea, Bell Telephone Laboratories, Inc., 463 West St., New York 14, N.Y.
4. J. W. Davis, Southern Bell Tel. & Tel. Co., Box 2211, Atlanta, Ga.
5. J. R. North, Commonwealth Associates, Inc., 209 East Washington Ave., Jackson, Mich.
6. Clarence Talsma, General Electric Company, 610 Electric Building, Omaha, Nebr.
7. R. M. Goar, Black & Veatch, 4706 Broadway, Kansas City, Mo.
8. E. F. Kotnik, R.R.1, Box 652, El Cajon, Calif.
9. A. E. Opdenweyer, Portland General Electric Co., 621 S.W. Alder, Portland 5, Oreg.
10. G. D. Floyd, Hydro-Elec. Power Comm. of Ont., 620 University Ave., Toronto, Ont., Canada
11. D. T. Michael, Cincinnati Gas & Electric Co., Box 960, Cincinnati, Ohio
12. John Hitt, Jackson & Moreland, Inc., 600 Park Square Bldg., Boston 16, Mass.

Representing the six Technical Divisions:

Communication—John Meszar, Bell Telephone Laboratories, Inc., 463 West St., New York 14, N.Y.
General Applications—H. F. Hoebel, American Gas & Elec. Service Corp., 30 Church St., New York 8, N.Y.
Industry—C. N. Clark, Duquesne Light Company, 435 Sixth Ave., Pittsburgh 19, Pa.
Instrumentation—C. F. Savage, General Electric Company, 570 Lexington Ave., New York 22, N.Y.
Power—E. I. Pollard, Elliott Company, 271 Church St., New York, N.Y.
Science and Electronics—J. G. Reid, Jr., National Academy of Sciences, 1145 19th St., N.W., Washington, D.C.

Alternates for Division Representatives:

Communication—C. E. Dean, Hazeltine Research Corp., 5925 Little Neck Parkway, Little Neck 62, N.Y.
General Applications—T. C. Johnson, General Electric Company, Room 324, Bldg. 41, Schenectady, N.Y.
Industry—H. W. Cory, Allis-Chalmers Mfg. Company, Hawley Works, Milwaukee, Wis.
Instrumentation—P. K. McElroy, General Electric Company, 275 Massachusetts Avenue, Cambridge 39, Mass.
Power—F. L. Lawton, Aluminum Laboratories, Ltd., 1800 Sun Life Bldg., Montreal 2, Que., Canada
Science and Electronics—D. E. Trucksess, Bell Telephone Laboratories, Inc., 463 West St., New York 14, N.Y.

Representing the Board of Directors:

W. R. Brownlee, Southern Services, Inc., Birmingham, Ala.
M. S. Coover, Dept. of Elec. Engg., Iowa State College, Ames, Iowa
J. H. Foote, Commonwealth Associates, Inc., 209 E. Washington Ave., Jackson, Mich.
M. D. Hooven, Public Service Elec. & Gas Co., 80 Park Place, Newark 1, N.J.
L. M. Robertson, Public Service Co. of Colorado, Denver, Colo.
J. C. Strasbourger, Cleveland Electric Illuminating Co., 75 Public Square, Cleveland 1, Ohio

Alternates for Board Representatives:

W. R. Clark, Leeds & Northrup Company, 4901 Stenton Ave., Philadelphia 44, Pa.
A. A. Johnson, Westinghouse Electric Corp., East Pittsburgh, Pa.
P. G. Wallace, Texas Power & Light Co., Fidelity Union Life Bldg., Box 6331, Dallas, Texas

The following provisions of the Constitution and Bylaws relate to the organization and procedures of the Nominating Committee.

Constitution

C30. There shall be constituted each year a Nominating Committee consisting of one representative of each geographical District, elected by its executive committee, one representative of each technical division elected by the division committee, and other members chosen by and from the Board of Directors not exceeding in number the number of technical divisions; all to be selected when and as provided in the Bylaws. The Secretary of the Institute shall be the secretary of the Nominating Committee, without voting power.

C31. The Executive Committee of each geographical District shall act as a nominating committee of the candidate for election as Vice-President of that District, or for filling a vacancy in such office for an unexpired term, whenever a vacancy occurs.

C32. The Nominating Committee shall receive such suggestions and proposals as any member or group of members may desire to offer, such suggestions being sent to the secretary of the committee. The Nominating Committee each year shall name one or more candidates for President, Treasurer, and the proper number of Directors, and shall include in its ticket such candidates for Vice-Presidents as have been named by the nominating committees of the respective geographical Districts, if received by the Nominating Committee when and as provided in the Bylaws; otherwise the Nominating Committee shall nominate one or more candidates for Vice-President(s) from the District(s) concerned.

C33. Independent nominations may be made by a petition of twenty-five (25) or more corporate members sent to the Secretary when and as provided in the Bylaws; such petitions for the nomination of Vice-Presidents shall be signed only by members within the District concerned.

Bylaws

B27. The secretary of the Nominating Committee shall give the members . . . not less than ten days notice of the first meeting of the committee, which shall be held not later than February fifteenth. At this meeting, the committee shall elect a chairman and shall proceed to make up a ticket of nominees for the offices to be filled at the next election. To insure that full consideration be given to all suggestions from the general membership, they must be in the hands of the secretary of the committee by December fifteenth. The nominations as made by the Nominating Committee shall be published in the March issue of *Electrical Engineering*, or otherwise mailed to the Institute membership not later than the first week in March.

B28. Petitions proposing the names of candidates as independent nominations for the various offices to be filled at the ensuing election, in accordance with C33 (Constitution) must be received by the secretary of the Nominating Committee not later than March fifteenth of each year, to be placed before that committee for the inclusion in the ballot of such candidates as are eligible.

B28.1. The candidates shall appear on the ballot, grouped alphabetically under the name of the office for which each is a candidate. The voting in each case shall be restricted to the nominees printed on the ballot. The ballot shall be mailed to the membership by April 15.

Asia Foundation Seeks Books for Asian Students

The Asia Foundation, a nonprofit, nonpolitical organization founded by private United States citizens, supports individuals and groups in Asia who are working for the attainment of peace, independence,

AIEE Members Visit Tidewater

Public Relations Department, Tidewater Oil Co.

TWO CANADIAN MEMBERS of the AIEE examine motor of a large pump at the gas plant of Tidewater Oil Company's Delaware (Md.) Refinery. A. S. Judd (*left*), Imperial Oil Ltd., Sarnia, Ont., and T. J. McClean (*right*), Canadian Oil Company, Ltd., Corunna, Ont., were among 150 AIEE members who recently toured the Delaware Refinery, 15 miles south of Wilmington.

personal liberty, and social progress. The Foundation maintains 18 offices in Asia which encourage and strengthen these individuals and groups in their work.

In the past 2½ years, the Foundation's special project, Books for Asian Students, has sent 600,000 selected books to more than 1,200 universities, colleges, libraries, and civic groups in Asia. These books were donated by 700 university and college groups, publishers, libraries, and individuals in the United States. The great need for books continues as evidenced by increasing requests.

Your contributions of books will be greatly appreciated. Items in every category on the university and college level, in good condition, published in 1948 or after, and works by standard authors regardless of date, can be sent directly to the following address: Books for Asian Students, 21 Drumm St., San Francisco 11, Calif.

Transportation costs from the donor to San Francisco and thence to Asia will be borne by the Foundation for substantial shipments. Further information for such contributions may be had by writing to the address given.

All contributions are tax exempt.

R. P. Crago Chosen Outstanding Young Engineer

J. H. Craig, chairman of the Award Organization Committee of Eta Kappa Nu, national electrical engineering honor society, has announced that R. P. Crago of Kingston, N. Y., has been named as the "Outstanding Young Electrical Engineer of 1957" in its annual nation-wide talent search. Mr. Craig also announced that Dr. W. R. Beam of Hamilton Square, N. J., and G. W. Stagg of Jackson Heights, N. Y., received Honorable Mention awards. The 1957 award is the 22nd in the series which

R. P. Crago

began in 1936. Formal presentation of the awards will be made at a banquet to be held February 3, 1958, during the Winter General Meeting of the AIEE in New York, N. Y.

Eligible for the award is any man who on May 1 of each year has been graduated not more than 10 years from a regular course in electrical engineering from an American college or university and who is not more than 35 years of age. Selection is made on the basis of the candidate's record of achievement in his chosen work; in his service in behalf of his community, state, or nation; in his cultural or aesthetic development; and for his professional activities.

Eta Kappa Nu, the sponsor of the annual award, is the national electrical engineering honor society founded at the University of Illinois in 1904. The organization has more than 28,000 members, 71 college, and 12 alumni chapters in the principal cities of the United States.

Selection of this year's recognition winner and honorable mention recipients was made by a Jury of Award consisting of the following engineering leaders: Chairman I. S. Coggeshall, director of international communications, Western Union Telegraph Co.; C. J. Beller, vice-president, Cleveland Electric Illuminating Co.; Dr. A. V. Haeff, vice-president and director of research, Hughes Aircraft Co.; R. R. Hough, assistant chief engineer, American Telephone and Telegraph Co.; Dr. W. E. Kock, chief scientist, Bendix Systems Division; and J. M. Wallace, manager, Meter Division, Westinghouse Electric Corporation.

To assist the Jury of Award in their deliberations, each year the nominations for the Outstanding Young Electrical Engineer are given a preliminary processing and evaluation by the Eta Kappa Nu's Award Organization Committee. The Committee membership for 1957 under the chairmanship of J. H. Craig included Robin Beach, L. Dwon, E. S. Lee, B. F. Lewis, J. W. Montstream, J. H. Mulligan, Jr., J. D. Ryder, R. I. Wilkinson, and F. W. Young.

The 1957 Outstanding Young Electrical Engineer has just turned 30 years of age. Recently he was promoted to director of engineering of the Military Products Division of the International Business Machines Corporation (IBM). Immediately prior to this advancement, he was general manager of the Kingston Military Products Center of the corporation. A graduate of the Carnegie Institute of Technology in 1948 and the recipient of the M.S. degree in E.E. from California Institute of Technology in 1949, Mr. Crago has had a truly meteoric rise in the IBM organization. Joining this company in August 1949 as a technical engineer in the Poughkeepsie laboratory, he was promoted to project engineer in late 1951 and less than two years later advanced to manager of engineering design. He was subsequently assigned complete research and development responsibility for Project High, a vital air-warning computer system the company is producing for the U. S. Air Force. He was elevated to the general manager position in April 1956. His duties there included the responsibility for engineering, manufacturing, finance, field engineering, and personnel for an autonomous division of some 3,500 individuals. Mr. Crago is a member of the Board of Trustees of Kingston Hospital, an elder of the First Presbyterian Church of Poughkeepsie, a member of the Board of Directors of the Kingston Chamber of Commerce, and has been most active in connection with youth activities in both church work and vocational guidance.

The Honorable Mention recipients have also compiled enviable records of accomplishment at comparatively young ages. Dr. W. R. Beam, at the age of 29, is the manager of microwave advanced development of the Tube Division of the Radio Corporation of America at Princeton, N. J. He is an established authority in the field of microwave electron tubes having made particularly significant contributions in connection with the reduction of fluctuation noise in traveling-wave tubes. Educated at the University of Maryland, Dr. Beam received the B.S.E.E. degree in 1947, the M.S. in 1950 and the Ph.D. in 1953. He has been extremely active in civic affairs in Hamilton Township, N. J., and is an accomplished violinist.

G. W. Stagg, at age 34 is senior engineer with the American Gas and Electric Serv-

MEMBERS OF THE ETA KAPPA NU Jury of Award are: *(around the table, from left to right)* I. S. Coggeshall, director of international communications, Western Union Telegraph Co.; R. R. Hough, assistant chief engineer, American Telephone and Telegraph Co.; C. J. Beller, vice-president, Cleveland Electric Illuminating Co.; Dr. A. V. Haeff, vice-president, and director of research, Hughes Aircraft Co.; J. M. Wallace, manager, Meter Division, Westinghouse Electric Corporation; and Dr. W. E. Kock, chief scientist, Bendix Systems Division.

ice Corporation in New York, N. Y. Mr. Stagg received the bachelor's degree in engineering from Massachusetts Institute of Technology in 1948 and the degree of master of business administration from New York University in 1955. He has been concerned in his present position with a large number of techno-economic studies of individual as well as interconnected power systems, particularly in the midwest. Mr. Stagg has been most active in youth work, especially as a member of the Big Brother movement in New York City.

The Eta Kappa Nu Dinner honoring recipients of the awards will be held Monday, February 3, at 7 p.m. at the Cornish Arms Hotel, 23rd St. and Eighth Ave., New York, N. Y. Tickets are $5 and reservations may be made through W. B. Groth, Bell Telephone Laboratories, Inc., 463 West St., New York 14, N. Y.

J. R. Suman To Receive John Fritz Medal for 1958

Four major national engineering organizations, cosponsors of the John Fritz Medal, one of the profession's most distinguished honors, have awarded it, for 1958, to J. R. Suman, of Houston, Texas, former vice-president and director of the Humble Oil & Refining Co. and of the Standard Oil Company of New Jersey.

The citation to accompany the award states the selection of Mr. Suman was made because he has been a "pioneer in the application of engineering principles to the development, production, and conservation of petroleum and natural gas; author; industrial statesman; and one who takes a keen interest and real pleasure in inspiring men to make the most of their talents."

The joint sponsors are the AIEE, the American Society of Civil Engineers, The American Society of Mechanical Engineers, and the American Institute of Mining, Metallurgical, and Petroleum Engineers (AIME). Mr. Suman is a former president and an honorary member of AIME. He will receive the John Fritz Medal at the annual banquet on the evening of February 19, 1958, during the AIME national convention in New York, N. Y. In 1943, he received the Anthony F. Lucas Gold Medal awarded by AIME for "distinguished achievement in improving the technique and practice of finding and producing petroleum."

Born in Daleville, Ill., Mr. Suman received his education at the University of Southern California and at the University of California. From the latter school he received the degree of B.S. in mining engineering in 1912.

Beginning his career with the Yellow Aster Mining & Milling Co., Randsburg, Calif., in 1911, he went with the Rio Bravo Oil Co., Houston, in 1912 as assistant geologist. He served there as chief engineer from 1913 to 1917. Then, for two years, he was technical superintendent of Texas and Louisiana for the Roxana Petroleum Corp.

Returning in 1919 to Rio Bravo Oil Co., he was assistant to the vice-president and general manager until 1925 when he became vice-president and general manager. He served in this capacity two years. He also was assistant manager of the East Coast Oil Co. of Mexico, a subsidiary of Southern Pacific, in 1922, and manager in 1923. He served, from 1923 to 1927, as general manager of the Texas operations of the Associated Oil Company of California.

Mr. Suman was a director of Humble Oil & Refining Co., from 1927 to 1933, at which time he was made vice-president in charge of production. In 1945, he was elected vice-president and director of Standard Oil Company of New Jersey and the following year became a member of the Executive Committee. He retired from the company in 1955 and opened an office in Houston as a consultant.

President in 1941 of AIME, Mr. Suman is a member of the American Association of Petroleum Geologists; Mid-Continent Oil & Gas Association; American Petroleum Institute, of which he is an honorary director; and the Independent Petroleum Association of America.

J. R. Suman

D. A. Quarles Receives Award of Merit

E. H. ANSON (*left*), president of the American Institute of Consulting Engineers, presents its Award of Merit to D. A. Quarles (HM '56), Deputy Secretary of Defense and past president of AIEE (1952-53) at their Annual Dinner on October 15, 1957, at the Waldorf Astoria Hotel, New York, N. Y. The citation reads "Able Administrator, noted Scientist, Leader in research, distinguished Engineer, dedicated Public Servant, and an outstanding example of how scientific training, broad technical experience, and conscientious endeavor can be combined successfully to meet the demands of Enlightened Government in a Free economy."

Over 30 Societies Plan for 1958 NESC

Over 30 engineering and scientific societies are completing plans for the 4th Nuclear Engineering and Science Conference (NESC) to be held as part of the 1958 Nuclear Congress at the Chicago, Ill., International Amphitheatre in March. According to J. W. Landis of the American Nuclear Society, Inc., and chairman of the Program Committee, approximately 200 papers will be approved for the following technical sessions: Commercial Use of Radioactive Tracers; Reactor Component Development, Fabrication, and Testing; Standardization, Codes, and Licensing; Reactors for Process Heat and Radiation; Production and Miscellaneous Applications of Radioisotopes; Reactor Operation and Maintenance; Fuel, Control, Moderator, and Coolant Materials; Experimental Power Reactors and Advanced Concepts; Health Physics and Instrumentation; Reactor Physics; Temperature Measurement and High Temperature Instrumentation; Waste Treatment and Disposal; Reactor Plant Instrumentation; Reactor Location and Safety; Thermal and Mechanical Design; Reactor Control Instrumentation; Progress in Commercial Power Reactor

Development; Reactor Plant Materials; Fuel Element Development, Fabrication, and Testing; Reactor Safety and Start-up Instrumentation; Reactor Systems Analysis; Research and Test Reactors and Critical Assemblies; Chemical Reprocessing; Water Contamination and Treatment; and Reactor Shielding and Containment.

Developments in atomic energy will be presented from the standpoint of engineers, physicists, metallurgists, and chemists.

The National Industrial Conference Board and the Atomic Industrial Forum, Inc., will jointly sponsor an Atomic Energy Management Conference which will be a part of the Nuclear Congress. This conference is designed to provide management with a comprehensive review of the progress that is being made throughout the world in the development of low-cost nuclear power and other industrial uses of atomic energy. Each year it brings together outstanding men of industry, science, and Government from many countries to discuss the latest promises and problems of this great new energy source and to evaluate the impact of atomic energy on our economy and management practices.

The Atomic Industrial Forum, Inc., ATOMFAIR will be held in conjunction with the technical sessions of the Nuclear Congress and will feature the latest developments in industrial uses of atomic energy. Registration for the ATOMFAIR is open to Nuclear Congress delegates and to science-minded people in industry.

Mr. Landis emphasized that preprints of Nuclear Congress papers will be available well in advance of the Congress at a nominal cost. These preprints may be ordered from the order form to be included in the Advance Program for the Nuclear Congress which is being distributed in January.

Those interested should request copies of this program from the secretary of the society to which they belong or from the Secretary of Engineers Joint Council, 29 W. 39 St., New York 18, N. Y.

J. K. Hodnette To Receive The Edison Medal for 1957

The Edison Medal Committee of the AIEE has awarded the Edison Medal for 1957 to J. K. Hodnette (AM '25, M '30, F '42), vice-president and general manager (chief operating officer), Westinghouse Electric Corporation, Pittsburgh, Pa. The presentation of the medal will take place during the general session of the 1958 Winter General Meeting, at the Hotel Statler, New York, N. Y.

The citation which will accompany the medal reads as follows:

"For his significant contributions to the electrical industry through creative design and development of transformer apparatus which marked new advances in protection, performance, and service. For his vision, judgment, and management skill which fostered and achieved the practical application of his ideas with resulting advancements in the electrical industry."

Mr. Hodnette was born March 23, 1902, at Notasulga, Ala. He received the B.S. degree in M.E. from Alabama Polytechnic Institute in 1922, after which he was with the Illinois Central Railroad for one year. In 1923, he joined the Westinghouse Electric Corporation at East Pittsburgh, Pa., as laboratory assistant in the High Voltage Insulation Testing Material and Process Engineering Laboratory. He moved to Sharon, Pa., in 1925 as transformer insulation engineer. He was named section manager, Distribution Transformer Engineering Development Section in 1932; division

J. K. Hodnette

engineering manager, Distribution Engineering Division in 1937; and engineering manager of the Transformer Division in 1940. From 1946 to 1949, he served as manager of the Transformer Division. He was elected a vice-president of the Westinghouse Electric Corporation in 1948. Mr. Hodnette transferred to the headquarters staff in Pittsburgh, Pa., in 1949 as vice-president and general manager, industrial products. From 1952 to 1955, he was vice-president and general manager, apparatus products. In 1955, he was appointed to his present position of vice-president and general manager (chief operating officer). He became a member of the board of directors in 1955.

In 1939, Mr. Hodnette was awarded the Westinghouse Order of Merit. He received the "Modern Pioneer Award" from the National Association of Manufacturers in 1940. Mr. Hodnette is the author of many technical articles and holds some 32 patents. A registered professional engineer, he is active in the National Electrical Manufacturers' Association. He served on the AIEE Electrical Machinery Committee, 1943-46.

Tulsa, Site of South West District Meeting

Courtesy Hopkins Photography Co.

Public Service News Photo

DOWNTOWN AREA of Tulsa, Okla. (*above, left*), where the AIEE District No. 7 Meeting will be held March 31-April 2, 1958. The DX Sunray Refinery, shown in the background, will be visited during an inspection trip. *Above, right:* Some committee chairmen at a recent general committee meeting on financing of the District No. 7 Meeting are: (*seated, left to right*) J. L. Hixon, finance chairman; R. K. Lane, general chairman; F. N. Wightman, program chairman; (*standing, left to right*) D. M. Allison, general vice chairman; and J. H. Heller, secretary.

Prize Rules for AIEE Papers

THE FOLLOWING are rules for the award of prizes for AIEE Papers which were approved by the Board of Directors on June 28, 1956, superseding those previously in effect.

General Information

In order to recognize and promote the contribution of meritorious papers, the AIEE has established a series of prizes which are available for annual award to members for outstanding papers. All awards are optional, not obligatory, and it is expected that discriminating judgment will be made by each responsible committee. Each prize consists of a sum of money and/or a Certificate of Award. Appropriate recognition will be given in *Electrical Engineering* and the AIEE "Year Book."

Prizes are available on the national level, known as Institute prizes; on the District level; on the Section level; and on the Branch or Undergraduate level.

To be eligible for an award, a paper must have been presented at a qualified technical meeting of the AIEE (Winter, Summer, Fall, or Pacific General Meeting; District Meeting; Special Technical Conference; Section, technical group, or Subsection Meeting; or Branch Meeting), except as provided in section *(b)* under Institute Prizes.

Any monetary prize will be divided between coauthors and each will receive a certificate. Certificates and checks for awards are prepared at Headquarters under the cognizance of the Prize Awards Committee. An equivalent gift may be substituted for the monetary prize.

To be eligible for any awards, the author, or at least one coauthor, of a paper must be a member (any grade) of the Institute and the other coauthors must be members of a professional society of comparable standing. District, Section, and Branch prizes will be limited to papers, one of whose authors is resident or employed within the respective territory. AIEE committee and subcommittee reports are not eligible for prizes.

All prizes will be awarded on the basis of papers presented during the administrative year, nominally August 1 to July 31, except as specifically stated within these rules. The technical excellence of the paper and its value in its field should constitute the primary basis of awarding of prizes rather than the numerical grades assigned by the original reviewers.

Prizes based on competitive presentation may be withheld whenever, in the opinion of the responsible committee, the number of papers is not sufficient to constitute a real competition. Such papers may be included in competition with those presented in the following year.

Institute Prizes

The awarding of the Institute prizes shall be the responsibility of the Prize Awards Committee, which is appointed annually by the Institute President in accordance with the Bylaws. The Institute prizes will be presented at the regular Winter General Meeting.

The Institute or national prizes will consist of (a) one from each Division, (b) one for papers sponsored by general committees and articles in *Electrical Engineering*, and (c) a Best Student Paper.

(a) *Division Papers:*

Only Transactions papers shall be eligible for Division prize awards. There shall be one first prize for each Division consisting of a certificate and $100. In special cases, additional certificates may be awarded at the discretion of the Committee on Prize Awards. All Transactions papers will be considered for Division prizes without formal offering in competition. The awards will be presented at the regular Winter General Meeting.

The Division prizes shall be judged by the Prize Awards Committee upon recommendation of a Prize Awards Subcommittee of each of the Divisions.

As an aid to the Prize Awards Committee, a Prize Awards Subcommittee shall be appointed by each Division chairman at the beginning of the administrative year and shall consist of not less than three members of the Division. Recommendations for Division prizes for papers presented during the administrative year shall be submitted by this Subcommittee to the Prize Awards Committee not later than September 1 of the following administrative year.

To assist the Divisional Prize Awards Subcommittee each Technical Committee Chairman is urged to submit nominations for the National Prizes to his Divisional Prize Awards Subcommittee, accompanied by a brief statement giving reasons why each paper is worthy of consideration.

(b) *Papers Sponsored by General Committees and Articles in Electrical Engineering:*

To encourage the authors of papers sponsored by general committees, and authors of article in *Electrical Engineering*, an additional prize consisting of a certificate and $100 has been set up. All such papers will be considered for this award if submitted in triplicate to the Institute Secretary before July 31 of the administrative year and accompanied by a written statement as to why it is of prize caliber.

(c) *Best Student Paper:*

A Best Student Paper award also is included among the Institute awards. This consists of a certificate and $100. All student papers which have won a prize in Branch or District student competition will be considered for an Institute award if submitted in triplicate to the Institute Secretary before July 1 of the administrative year in which presented and accompanied by a written statement as to when and where presented.

District Prizes

The awarding of District prizes shall be the responsibility of the Award of District Prizes Committee which shall be appointed annually by the District Vice-President and shall consist of not less than three Members or Fellows of the Institute. Judges of oral presentation of Student papers need not be the same as judges of written presentation, and they may include Associate or non-Institute members when necessary. The District prizes will be presented at a meeting within the District or at some other meeting upon approval of the District Executive Committee.

The District Prizes comprise (a) a best paper prize for any Transactions paper prepared by a resident of the District consisting of a certificate and $75, and a second prize consisting of a certificate and $50; and (b) a best paper prize presented to an undergraduate Student member in district competition consisting of a certificate and $25, and a second student prize consisting of a certificate only.

(a) *Best District Transactions Paper:*

All Transactions papers presented during the administrative year, nominally August 1 to July 31, will be considered for District prizes without formal offering in competition. Transactions papers selected by Technical Committees of the Divisions and the General Committees for consideration as Institute prize papers will be classified according to District allocation, as determined by the residency of the author or authors. In the case of member coauthors from more than one District, a Transactions paper shall be eligible in all such Districts. A list of these Transactions papers for each District shall be forwarded by the Headquarters staff to the District Secretary for consideration as the District prize papers. In addition to these papers, each District may include for consideration as District prize papers, any eligible Transactions paper, whether or not it is among those called to their attention by Headquarters. A paper is eligible to receive both Institute and District prize awards.

(b) *Best Student Paper:*

The District Student Prize Papers competition is limited to papers which have received first prize in a Branch competition.

Section Prizes

The awarding of Section prizes shall be the responsibility of the Section Prizes Committee which is appointed annually by the Section chairman and shall consist of not less than three Associate Members, Members, or Fellows of the Institute.

Prizes also are available for papers presented by Section members, but because of the wide variation in the character of the Sections, no very definite rules are provided. A sum of $100 is available for each Section to be divided at the discretion of the Section, but with a maximum of $50 for any one prize and a certificate for each winner. When three or more papers are submitted for competition to the Secretary of the Section, arrangements shall be made for presentation before the Section at a meeting set aside for that

purpose and a committee selected to judge the contest.

The award of the Section prize will be made at a meeting of the Section.

Branch (Undergraduate) Prizes

The Award of Branch Prizes Committee shall be appointed anually by the Student Counselor and shall consist of not less than three Associate Members, Members, or Fellows. When necessary, a non-Institute member may be selected.

Two awards for each Branch are available. The first prize consists of a certificate and $10 plus an allowance of 13¢ per mile one way for 800 miles or less and 10¢ per mile one way for the remaining distance to the District student prize paper competition. The second prize consists of a certificate. When three or more papers are submitted to the secretary of the Branch, arrangements shall be made for presentation before the Branch at a meeting set aside for that purpose and committees selected to judge each such contest.

It is not the primary purpose of Student papers to contribute to the technical advancement of the profession; they should constitute a vehicle for the training and stimulation of future contributors to the profession. To this end, emphasis has been placed on written presentation and the exercise of engineering thinking rather than on technical value. The papers shall be graded in accordance with the following basis:

A. Written Presentation
Originality—13%
Survey of subject (analytical procedure)—10%
Importance—10%
Appropriateness—6%
Mode of expression
(1) Logical organization of material for clarity, forcefulness, and interest. Appropriate headings are essential (7%)
(2) Concise and coherent expression of thoughts in good English and with proper choice of words (7%)
(3) Effective and judicious use of pictorial and graphical presentation (7%)
Adequate introduction and closure (6%)

B. Oral Presentation
Speaking technique—12%
Style (organization of material)—12%
Introduction and conclusion—5%
Discussion—5%

For purposes of grading student papers, originality should be interpreted to include credit for (a) individual treatment of the subject by the author and his own mode of expression in writing the paper, and (b) exposition of a technique, apparatus, device, investigation, theory, or analysis that is original with the author. No credit under originality should be allowed for direct copying of other work.

The award of the Student prizes should be made at a meeting of the Branch.

Institute and District prizes for Student papers are also provided as indicated under Institute Prizes (Section *c*), and District Prizes (Section *b*).

Effective Date of Rules

These rules became effective with the administrative year beginning on August 1, 1956.

Procedure for Revision

These rules for prize awards are subject to revision by the Board of Directors of the Institute.

McMillan Memorial Aided by Portland Section Rummage Sale

In late September, the Portland Section of the AIEE held a Scientific Equipment Rummage Sale to raise funds to furnish and equip a student counseling room in the new Oregon Museum of Science and Industry in honor of the late F. O. McMillan, past president of the AIEE, 1951-52.

A committee, consisting of Chairman P. M. Sweeney, C. M. Murphy, N. E. Cole, Jr., A. E. Opdenweyer, I. N. Tull, Jr., and R. M. Pool started planning the sale early in 1957.

In the Portland area, 200 leading business firms were contacted and asked to donate "White Elephant" equipment of an electrical, optical, or mechanical nature. In addition, 200 posters were displayed in public schools in the area and the Rose City Transit Company donated advertising space on all buses. Numerous radio and TV spot announcements, plus excellent press coverage combined to give the sale wide publicity. All publicity was aimed at obtaining donations as well as attendance at the sale.

Donations were picked up by four station wagons and were stored at the location of the sale in the Portland General Electric Company's Service Center.

Over 3,000 people attended the sale during a 12-hour period. Some 930 items, representing over 80% of the donations, were purchased for a net profit of $1,200.

A total of over $4,000 has now been raised for the McMillan Memorial from donations, the rummage sale, and other projects. The goal is $12,000. Friends of the late Mr. McMillan wishing to contribute may send checks made out to the Oregon Museum of Science and Industry (F. O. McMillan Memorial) to R. R. Bracchi, Chairman, c/o General Electric Company, Apparatus Service Shop, 2727 N. W. 29th, Portland 10, Oreg. These contributions are tax deductible.

R. M. POOL; J. G. Kirwan, Portland Section chairman; and A. E. Opdenweyer *(standing, left to right)* supervise while rummage sale chairman P. M. Sweeney prices a switch for Portland Section Scientific Equipment Rummage Sale held to raise funds for F. O. McMillan Memorial.

Fortescue Fellowship Applicants Must File by February 15, 1958

Funds have been made available for one or more Charles LeGeyt Fortescue Fellowships for 1958-59. The awards are made to postgraduate students in the field of electrical engineering who have received their baccalaureate degree from a duly recognized technical school in the United States or Canada. The amount of the award is to be determined by the committee in charge.

Candidates for the Charles LeGeyt Fortescue Fellowships should file applications on the form provided by AIEE so that they reach the Chairman of the Fellowship Committee by February 15, 1958. Awards will be made not later than

April 2. Copies of the application forms are available at accredited colleges or at AIEE Headquarters, 33 W. 39th St., New York 18, N.Y.

The Charles LeGeyt Fortescue Fellowship, sponsored by AIEE, was established in 1939 as a memorial to Charles Fortescue in recognition of his valuable contribution to the electric power industry. To this end, the Westinghouse Electric Corporation, with which Dr. Fortescue was associated throughout his professional career, set up a trust fund of $25,000 to provide graduate fellowships in electrical engineering.

The successful candidates are selected by the AIEE committee which administers the fund. In 1957-58, one scholarship of $2,000 was awarded.

It is intended that candidates shall pursue their studies at accredited engineering schools and engage in research problems meeting the approval of the Fellowship Committee. To be eligible, the student must have received a bachelor's degree from an accredited college by the time his work under the fellowship would begin, provided he does not hold or subsequently receive any other fellowship which carries a stipend greater than the tuition required by the institution at which the graduate work is to be undertaken.

Automatic Optimization Will Be Theme of Conference

Improved performance motivates the design and application of measurement and control systems. In his drive for improved performance, the control engineer has come up with techniques which automatically optimize performance. The techniques are just beginning to blossom and to reach practical application. Recognizing their future importance to the engineering professions, the Instruments and Regulators Division (IRD) of the American Society of Mechanical Engineers (ASME) has planned its 4th annual conference as a meeting ground on which control engineers from all industries will have an opportunity to learn and discuss the ideas, problems, and applications of automatic optimization.

ASME's Wilmington, Del., section will host the conference, scheduled for April 2-4, 1958, at the University of Delaware. Each of the major American technical societies—AIEE, Institute of Radio Engineers (IRE), Instrument Society of America (ISA), American Institute of Chemical Engineers (AIChE)—with professional groups analogous to the IRD will participate in the conference by sponsoring top quality technical papers centered around the theme which is: Automatic Optimization. The makeup of the program committee demonstrates the cross-society effort:

General Chairman—C. R. Otto, 1958 IRD chairman, E. I. du Pont de Nemours & Co. (Inc.)

Technical Program Chairman—W. E. Vannah, secretary-treasurer of American Automatic Control Council, editor of *Control Engineering*, McGraw-Hill Publishing Co.

Local Program Chairman—L. Bertrand,

Virginia Mountain Section

The Roanoke (Va.) Times photo

J. O. BEWLEY, JR., Virginia Mountain Section chairman, from Roanoke, Va., shows J. B. Whitmore the membership prize gavel. This Section achieved top membership increase (79%) for the entire United States. Mr. Whitmore was chairman during last year's winning session. The group, founded in 1951, now has 230 members.

Lehigh Valley Section

OFFICERS of the Lehigh Valley Section and Scranton Division of the AIEE and the principal speaker for their dinner meeting held at the Fox Hill Country Club, West Pittston, Pa., are: (*seated, left to right*) W. R. Dunkle, Allentown, chairman of the Lehigh Valley Section; Dr. W. B. Knowles, engineering psychologist at General Electric's advanced electronics center who addressed the group on "Human Engineering"; and F. P. Fletcher, Scranton, manager of the Scranton Division; (*standing, left to right*) L. Nonemaker, Allentown, secretary-treasurer of the Lehigh Valley Section; R. P. Ehas, Scranton, meeting chairman; and A. Plonsky, Scranton, Lehigh Valley Section vice-chairman.

Wilmington Section of ASME, E. I. du Pont de Nemours & Co. (Inc.).

AIEE Papers Chairman—J. G. Truxal, 1958 chairman of AIEE Feedback Control Committee, Brooklyn Polytechnic Institute

IRE Papers Chairman—E. M. Grabbe, 1958 chairman of IRE Professional Group on Automatic Control, Ramo-Wooldridge Corp.

ISA Papers Chairman—R. P. Bigliano, ISA Feedback Control Systems Committee, E. I. du Pont de Nemours & Co. (Inc.).

AIChE Papers Chairman—J. M. Mozley, AIChE Process Control Division, Johns Hopkins Hospital

The University of Delaware is providing rooms and six meals at such a low rate that total expenses per registrant during the entire conference will be within $30. Because this arrangement is based upon moving students' belonging out of every other room, the University will have to know in advance how many rooms to make available. People planning to attend should request registration blanks from L. Bertrand, Instrument Department, Engineering Service Division, Louviers Building, E. I. du Pont de Nemours & Co. (Inc.), Newark, Del., just as soon as they know their plans.

J. J. Raffone Named Editor of Eta Kappa Nu *Bridge*

J. J. Raffone (AM '54), special engineering writer, General Electric *Review*, Schenectady, N. Y., has been named editor and business manager of *Bridge*, the magazine published by Eta Kappa Nu Electrical Engineering Honor Society.

Mr. Raffone succeeds A. B. Zerby (AM '38), executive secretary of Eta Kappa Nu, who also had been serving as editor and business manager of the magazine. An announcement of the change in editorship, published in *Bridge*, stated that the continual growth of Eta Kappa Nu over the years has proportionately increased the burden of administrative work upon the executive secretary, Mr. Zerby. The appointment of another man to assume full responsibility for the magazine now releases him to devote more of his time and experience to the functional affairs of Eta Kappa Nu. Mr. Zerby has assumed the title of publishing editor of *Bridge*.

J. J. Raffone

Mr. Raffone holds a B.S. degree in E.E. from the Missouri School of Mines and Metallurgy. He is also a graduate of the Magazine Writers' Institute, Rockefeller Center, New York, N. Y.

In February 1951, he was employed by the General Electric Company as a technical writer. After a year of rotating assignments on the company's Test Engineering Program, he accepted a position as instruction-book writer with General Electric's gas turbine department. Shortly afterward, in March 1952, he was called on to assist in carrying out a newly instituted publishing policy of the General Electric *Review*. Mr. Raffone has functioned as special engineering writer, General Electric *Review*, with duties of associate editor and now, research and engineering editor, from March 1952 to the present. His responsibilities range from close collaboration with engineer and scientist authors, artists, and photographers, writing feature articles and special reports, to planning editorial material and executing the design of magazine layouts.

Organizations Mr. Raffone participates in include the following: American Association for the Advancement of Science, American Astronautical Society, Society of Technical Writers, Schenectady Society of Professional Engineers, and Mohawk Association of Scientists and Engineers.

He was formerly managing editor of the *Journal of Astronautics*, and is a member of the board of editors of the Technical Writing *Review*.

Two AIEE Members Receive 1957 d'Humy Award

Two Western Union engineers have received an award for one of the most important telecommunications inventions of the 20th Century—frequency-modulated carrier telegraphy.

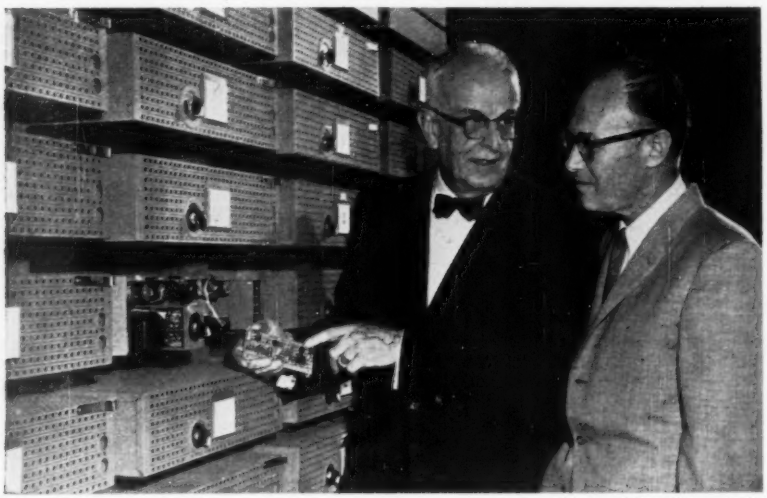
J. E. Boughtwood (AM '41) and F. B. Bramhall (F '44) were honored with the 1957 d'Humy Medal for their research, basic inventions, development, and application of f-m carrier to commercial telegraphy.

Presentation of the three-inch bronze medallion, accompanied by a certificate and honorarium, was made to each man by Western Union President W. P. Marshall, at a special ceremony in the company's auditorium, 60 Hudson St., New York, N. Y., on November 1. Several hundred engineering, research, and scientific workers from Western Union and other companies witnessed the ceremony.

The award to Mr. Boughtwood was made ". . . for fundamental scientific explorations and basic inventions in the field of frequency-modulated carrier telegraph systems." A native of Medford, Mass., Mr. Boughtwood has been employed in engineering and research activities with Western Union since his graduation from Northeastern University in 1930. He has specialized in the application of electronics to telegraph transmission, a field in which he has been granted important patents.

Mr. Bramhall received his award ". . . for contributions to the art of frequency-modulated carrier telecommunication and for technical direction leading to its wide adoption." Mr. Bramhall, born in Camptown, Pa., was gaduated from Pennsylvania State College in 1919 and joined Western Union's engineering organization in 1920. His work has included all aspects of telegraph transmission, a subject about which he has written numerous technical articles.

The d'Humy Medal was established in 1956 by Western Union in recognition and commemoration of the achievements of the late Fernand E. d'Humy, vice-president and director of the company. The award is made periodically for a most significant contribution to the telegraph art.



Courtesy Western Union Telegraph Co.

WESTERN UNION ENGINEERS F. B. Bramhall *(left)* and J. E. Boughtwood, honored with the 1957 d'Humy Medal, check operation of frequency-modulated carrier telegraph circuits at company's New York headquarters building. The two engineers received the medal award for their research, basic inventions, development, and application of FM carrier to commercial telegraphy. Carrier equipment has created 3,370,346 miles of "phantom" telegraph circuits of superior dependability, without constructing additional wires.

COMMITTEE ACTIVITIES

EDITOR'S NOTE: *This department has been created for the convenience of the various AIEE technical committees and will include brief news reports of committee activities. Items for this department, which should be as short as possible, should be forwarded to R. S. Gardner at AIEE Headquarters, 33 West 39th Street, New York 18, N. Y.*

General Applications Division

Air Transportation Committee (Peter Duyan, Jr., *Chairman;* D. H. Scott, *Vice-Chairman;* F. L. Lyons, *Secretary*). The Air Transportation Committee held an Air Transportation Conference in conjunction with the East Central and Middle Eastern District Meeting in Dayton, Ohio, on May 7-9, 1957. Ten sessions of this meeting and conference were devoted to air transportation at which 60 technical papers were presented and approximately 400 were in attendance.

The total work of all of the Air Transportation Committee Subcommittees can briefly be outlined as follows:

(1) An Aircraft Equipment Electrical Insulation Test Code has been issued for trial use.

(2) Consideration is being given to the problems of high altitude, corona, nuclear radiation, and pulse generating equipment on insulation.

(3) A Guide Report on Standardization of Presentation of Aircraft Generator and Regulator Characteristics is, at the present time, being presented to the Standards Group for approval.

(4) The method of rating airborne electrical apparatus has progressed considerably for both blast and self-cooled equipment.

(5) AIEE No. 750 "Aircraft Electric Systems Guide Report" revision is in the process of finalization and soon will be submitted to the Standards Committee.

(6) Inductive testing requirements, establishment of basic definitions on frequency modulation, and standards of voltages and frequencies for missiles are progressing.

Work is under way for a Technical Conference to be held in conjunction with the Buffalo, N. Y., Summer General Meeting in June 1958.

Production and Application of Light Committee (D. W. Rowten, *Chairman;* R. D. Churchill, *Vice Chairman;* C. W. Burney, *Secretary*). Perhaps the greatest single contribution of the Production and Application of Light Committee has been its support and contribution to the proposed Grey Book, "Electrical Distribution Systems for Commercial Buildings, Chapter 7, Lighting."

Industry Division

Industrial Power Rectifiers Committee (J. K. Dillard, *Chairman;* C. A. Langlois, *Vice-Chairman;* M. M. Morack, *Secretary*). A great deal of Committee effort is being directed toward work on standards:

1. The draft of the International Electrotechnical Commission (IEC) Standards for mercury-arc power rectifiers has been accepted by all 60 nations voting.

2. The revised American Standard C34 for pool-cathode, mercury-arc power converters has been approved by the AIEE Standards Committee and submitted to ASA for their approval.

3. The Mechanical Rectifier Subcommittee has prepared a preliminary draft of definitions for mechanical rectifiers which will be submitted as a proposed standard.

4. The Working Group on Protection of Electronic Power Converters has submitted a chapter on fault characteristics of power rectifiers to the Low-Voltage Air Circuit Breaker Subcommittee which is preparing a guide for the calculation of faults on d-c systems.

The Industry Division Committee has approved a change in the scope of the Committee to permit the establishment of a Power Applications of Metallic Rectifiers in Industry Subcommittee. The scope of the Subcommittee is being worked out with the Metallic Rectifiers Committee and will be submitted to the Technical Operations Department for their approval.

Current items of interest which the Committee is delving into consist of a revision of the Committee report published several years ago, giving a complete bibliography on rectifiers; work on the probability of using electronic exciters for large generators; and preliminary work relative to the conversion equipment required for high-voltage d-c transmission systems.

Instrumentation Division

Special Instruments and Auxiliary Apparatus Committee (Harry Sohon, *Chairman;* E. B. Curdts, *Vice-Chairman;* C. Stansbury, *Secretary*). During its first year, this Committee has established two new Subcommittees, one on Fundamental Standards and one on Measurements of Ground Resistance.

The Rotary Speed Measurement Subcommittee is circulating a draft of a proposed code. Members of the Rotating Machinery Committee assisted in the preparation of the present draft, and it is expected that a draft will be available to submit to the Standards Committee.

Power Division

Power System Communication Committee (L. E. Ludekens, *Chairman;* G. E. Farmer, *Vice-Chairman, East;* R. L. Brinton, *Vice-Chairman, West;* L. G. Walter, *Secretary*). The new administrative year of the Power System Communications Committee commenced with the session held during the week of June 24, 1957, which is the first opening period under the Committee's new scope, recognizing the application of microwave and other forms of power type communications in the Power Division.

A very successful technical activities program was held with the Relay Committee. In addition, a symposium was held jointly, including a considerable number of System Operating people. Interesting technical operating questions were posed during the course of this symposium.

Later, it was agreed in the Executive Committee to explore further the field of

San Francisco Section

Morton-Waters Co., Photographers

C. F. DALZIEL (*left*), chairman of the San Francisco Section, congratulates D. I. Cone (*right*), who received a certificate of appreciation for invaluable service as Director for the years 1953-57. Looking on are W. S. Pritchett (*second from left*), past chairman of the Flight Test Instrumentation Committee and J. H. Cox (*second from right*), newly elected Fellow and chairman of the San Jose Subsection.

Conference Papers Open for Discussion

Conference papers listed below have been accepted for AIEE *Transactions* and are now open for written discussion until January 27. Duplicate double-spaced typewritten copies of each discussion should be sent to E. C. Day, Assistant Secretary for Technical Papers, American Institute of Electrical Engineers, 33 West 39th St., New York 18, N. Y., on or before January 27.

57-166 **Radio Interference from High-Voltage Transmission Lines as Influenced by the Line Design.** *G. E. Adams*

57-537 **Calculation of Transmission-Line Lightning Voltages by Field Concepts.** *R. Lundholm, R. B. Finn, Jr., W. S. Price*

57-689 **The Evolution of the Modern Waterwheel Generator in Canada.** *G. D. Floyd, H. R. Sills*

57-799 **Transient Recovery Voltages on Power Systems. Part II. Practical Methods of Determination.** *S. B. Griscom, D. M. Sauter, H. M. Ellis*

57-898 **A Precision High-Speed Telemetering Oscillator.** *D. Garshman, J. A. Fraunfelder*

57-1100 **Vacuum Switch Properties for Power Switching Applications.** *H. C. Ross*

Preprints may be purchased at 40¢ each to members, 80¢ each to nonmembers, if accompanied by remittance or coupons. Please order by number and send remittance to: AIEE Order Department, 33 West 39th St., New York 18, N. Y.

power communications as related to systems operations, and to encourage submission of papers on this and microwave relaying for the next year.

During the Executive Committee meeting, recommendations were made to plan for the New York symposium session, with the Relay Committee, on the subject of "Microwave Channel Requirements for Protective Relaying."

A review was made of the six standing Subcommittees and the status of their present activities. It was agreed that the present chairman of this Committee produce a written report by the Subcommittee Chairmen, as derived from information submitted by members of the Subcommittee. All material to be reviewed and decisions made at the New York Committee meeting. These Subcommittees are: Subcommittee #1—Executive, L. G. Eaton, Chairman; Subcommittee #2—Methods of Measurement, E. S. Koesan, Chairman; Subcommittee #3—Microwave, T. A. Cramer, Chairman; Subcommittee #4—Carrier Bibliography, K. O. Sten, Chairman; Subcommittee #5—Carrier Radiation, L. G. Walker, Chairman; Subcommittee #6—Equipment Design Standards, J. A. Becker, Chairman.

A new Committee is being considered, titled "Power Systems Communications Line Protection." It has been suggested that each registered member of the present Committee be contacted by the chairman concerning that member's ability to participate and willingness to contribute papers of technical interest to the proposed new Committee.

Science and Electronics Division

Magnetic Amplifiers Committee (H. W. Lord, *Chairman*; A. B. Haines, *Vice-Chairman*; R. W. Robert, *Secretary*). Aid to local AIEE Sections interested in forming technical discussion groups on magnetic amplifiers is a matter now being given careful consideration by the Magnetic Amplifiers Committee. Individual Committee members plan to try to stimulate interest in the formation of such groups in their own local Section and the National Committee stands ready to help local Sections obtain qualified speakers in the field upon request.

Residents of the Newark, N. J., area will be interested in the plans of the Education Committee of the New Jersey Division of the AIEE to hold a six session study group on "Application and Selection of Magnetic Amplifiers." Meetings of this group will be held during February or March 1958 in Newark. The Magnetic Amplifiers Committee is aiding the local group in the selection of speakers for the various sessions.

A 1958 Special Technical Conference on Nonlinear Magnetics and Magnetic Amplifiers will be held in Los Angeles, Calif., August 6-8. The chairman of the Steering Committee for this conference is A. B. Rosenstein, who is also chairman of the West Coast Subcommittee of the Magnetic Amplifiers Committee. The Technical Paper Committee for this conference, headed by R. C. Byloff, is now actively soliciting papers for the conference. The final date for submission of papers is tentatively set for February 1, 1958. In view of the interest demonstrated at the two previous Special Technical Conferences, it is anticipated that the 1958 Conference will be a great success.

Nucleonics Committee (P. N. Ross, *Chairman*; G. A. Morton, *Vice-Chairman*; T. R. Kohler, *Secretary*). The Nuclear Engineering and Science Conference has become a major forum for presentation and exchange of information in the atomic energy field. The Nucleonics Committee, working with the Nucleonic and Radiation Instrumentation Committee, is, therefore, again making a concerted effort to assure strong AIEE participation.

It has become evident that greater emphasis and attention is needed on the problems of standards, codes, and safety requirements of reactor power plants. A Steering Committee currently is studying the advisability of forming a subcommittee to cover this area. A review of its findings is planned for the next Committee meeting in conjunction with the Winter General Meeting.

AIEE FELLOWS ELECTED

Board of Directors Meeting, October 11, 1957

Edward Hiram Anson (M '54), senior vice-president, Gibbs & Hill, Inc., New York, N. Y., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to railway electrification, power supply systems and engineering management." Mr. Anson was born in AuSable Forks, N. Y., on December 9, 1902. He received the B.S. degree in E.E. from New York University College of Engineering in 1925. He began his career as engineering assistant with the firm of Gibbs & Hill, Inc., in 1925, and left the firm in 1927 to accept a position as engineer with the American Steel and Wire Company. From 1928 to 1931, he was assistant catenary engineer with Jackson and Moreland, consulting engineers of Boston, Mass., and at the end of that time, rejoined Gibbs & Hill as assistant engineer. He became an engineer with that firm in 1935, was promoted to assistant vice-president in 1940 and to vice-president the following year. Since 1953, he has been senior vice-president. In the course of his duties, he has been engaged in the practice of consulting engineering, designing, and engineering construction. From 1943 to 1945, Mr. Anson was president of a foreign affiliate of his company, Gibbs & Hill, S.A., in Mexico. He is a director of Gibbs & Hill, Inc., and is vice-president and director of Foreign Industrial Equipment Corporation. Mr. Anson is a registered professional engineer in the states of California, Connecticut, Delaware, Florida, Idaho, Illinois, Indiana, Kansas, Louisiana, Maryland, Massachusetts, Michigan, Missouri, New Jersey, New York, North Carolina, Ohio, Oklahoma, Pennsylvania, Rhode Island, South Carolina, Texas, Virginia, Washington, and West Virginia. He is a member of the American Institute of Consulting Engineers, served on its Council in 1955, and is now its president. He is also a member of the American Society of Civil Engineers, American Nuclear Society, American Institute of Management, American Railway Engineering Association, Society of American Military Engineers, and the Consulting Engineers Association of California. In 1955, Mr. Anson received a

Certificate of Distinction from the College of Engineering, New York University, in recognition of his outstanding work in his profession, and the New York University Heights Colleges Alumni Association presented him with its Achievement Award in 1956.

George W. Bean (AM '36, M '43), chief engineer, Texas Electric Service Company, Fort Worth, Texas, has been transferred to the grade of Fellow in the AIEE ". . . for engineering achievements and administrative ability in the design and building of a rapidly expanding far-flung power system." Mr. Bean was born in Abbotsford, Wis., on March 13, 1897, and attended Tri-State College, Angola, Ind. In 1921, he began his career as central office engineer, Western Electric Company Hawthorne Works, Chicago, Ill. Following this, he was foreman on field construction with Wisconsin-Minnesota Lighting and Power Company, Eau Claire, Wis. From 1923 to 1927, he was resident engineer with Texas Power and Light Company. During these years, he was in charge of construction of substations and transmission lines and power lines representing several million dollars. Much of the present system of Texas Electric Service Company (which at that time was under the management of Texas Power and Light Company) was constructed under his direct supervision. From 1928 to 1930, he was electric design engineer with Texas Power and Light at Dallas. In 1931, with the realignment of the corporate setup of Texas Electric Service Company, Mr. Bean went to Fort Worth and continued as design engineer. In 1934, he was appointed chief engineer of Texas Electric Service Company, the position he holds at present. In this capacity, he has been in active charge of the engineering, planning, design, and construction of the generation, transmission, and distribution facilities of Texas Electric Service Company. Mr. Bean served for several years on the Transmission and Distribution Committee of the Edison Electric Institute. He has been quite active in the development of the Power Distribution Conference sponsored by the University of Texas and held in Austin each year since its inception in 1948. He is a registered professional engineer in the State of Texas. Mr. Bean served on the AIEE Automatic Stations Committee (1944-47), and is presently serving as a member of the Lamme Medal Committee (1956-59).

Robert Simpson Cannon (AM '27, M '33), supervisor of engineering and construction, Plantation Pipe Line Company, Atlanta, Ga., has been transferred to the grade of Fellow in the AIEE ". . . for important contributions in the application of advanced electrical systems to all phases of refined petroleum product pipe line operations." Mr. Cannon was born in Foreman, Ark., on February 15, 1905. He received the B.S. degree in E.E. from the University of Illinois in 1926, after which he spent a short time with Westinghouse Electric Corporation, Pittsburgh, Pa., as a student engineer. He then was electrical draftsman for the Pennsylvania Railroad, Altoona, Pa., and in 1927, became an electrician for the New York & Honduras Rosario Mining Co., San Juancito, Honduras. From 1928 to 1930, he was distribution engineer for the Mexico Light & Power Company, Mexico City, Mexico, and from 1930 to 1936, was electrical engineer for the Lago Petroleum Corporation, Maracaibo, Venezuela. In 1936, he returned to the United States as sales engineer for the Westinghouse Electric Corporation, Pittsburgh, Pa. From 1937 to 1943 he was assistant chief engineer, Standard Oil Company, Caripito, Venezuela. From 1943 to 1950, he was employed by the Creole Petroleum Corp., Caracas, Venezuela, as assistant division chief engineer, division electrical supervisor, and division mechanical and electrical engineer. He joined the Plantation Pipe Line Company in 1951 as chief electrical engineer. At present, he is on loan assignment to Nord-West Oelleitung G.m.b.H. (Northwest Oil Line, Inc.), Hamburg, Germany, as control and automation adviser. Mr. Cannon is a member of the American Petroleum Industry and has served on its Committee on Electrical Standards. He has served on the AIEE Petroleum Industry Committee (1954-57, chairman 1956-57), and on the Industry Division Committee (1956-57).

Charles Francis Dalziel (AM '33, M '39), professor of electrical engineering, University of California, Berkeley, Calif., has been transferred to the grade of Fellow in the AIEE ". . . for effective teaching of electrical engineering and original research on the effects of electric currents in the human body." Prof. Dalziel was born in San Francisco, Calif., on June 6, 1904. He received the following degrees from the University of California: B.S., 1927; M.S., 1934; and E.E., 1935. He was employed by the Midland Counties Public Service Corp., General Electric Company, and San Diego Gas and Electric Co. before joining the faculty of the University of California as an associate in the Division of Electrical Engineering in 1932. He was made instructor in 1933, assistant professor of electrical engineering in 1938, associate professor in 1942, and professor in 1948. Prof. Dalziel is a registered professional engineer in the State of California. He is a member of the Pacific Coast Electrical Association, Eta Kappa Nu, Tau Beta Pi, and Sigma Xi. He is the author of 70 technical papers published in various professional journals in the United States and in foreign countries. During his career, Prof. Dalziel has had various assignments as consulting engineer, electrical expert, and expert witness. He was appointed Fulbright visiting professor to Instituto Elettrotecnico Nazionale Galileo Ferraris, Turin, Italy, for the academic year 1951-52. He served as Commissioner of Examinations (electrical), California State Board of Registration for Civil and Professional Engineers, May 1954 to September 1956. He was appointed consulting electrical engineer, Kaiser Engineers, Division of Henry J. Kaiser Co., Oakland, in July 1956. Prof. Dalziel has been very active in the San Francisco Section of the AIEE, serving as secretary-treasurer, 1955-56; vice-chairman, 1956-57; and, at present, is chairman of the Section, 1957-58. His research has included the subjects of electric shock, electric safety, electric hazards, power system stability, and power system protection. Prof. Dalziel has served on the following AIEE Committees: Safety (1942-57), Standards (1942-56), Liaison Representative on Standards Committee (1951-53), and the Student Branches Committee (1954-56).

Edward Nelson Dingley, Jr. (M '56), staff research engineer, Electronic Communications, Inc., St. Petersburg, Fla., has been transferred to the grade of Fellow in the AIEE ". . . for his many contributions in the field of electrical engineering to the defense of the United States." Mr. Dingley was born in Kalamazoo, Mich., on July 18, 1902. He attended Massachusetts Institute of Technology from 1922 to 1925 and received the B.S. degree in E.E. from George Washington University in 1936. From 1925 to 1932, he held positions with the Radio Corporation of America and with the Mackay Radio and Telegraph Co. He then became affiliated with the

Conway Studios Corp.

E. H. Anson

Courtesy G. M. Dozois

G. W. Bean

R. S. Cannon

ASUC Photography

C. F. Dalziel

Phil Graham Photography

E. N. Dingley, Jr.

The Toledo Edison Co.
Alois Hoefle

W. M. Joslin

D. D. Knowles

D. E. Marshall

John Maxian, Jr.

Navy Department as an electronics engineer at the U.S. Naval Research Laboratory. In 1934, he was transferred to the Bureau of Ships. During World War II, he performed active duty and, as a Captain USNR, served as deputy director of the U. S. Naval Electronics Laboratory at San Diego, Calif. He is the recipient of a commendation citation from the Chief of the Bureau of Ships, and in 1956 " . . . in recognition of ingenious solutions which he has developed to complex communications problems of the National Security Agency . . ." he was awarded the distinguished civilian service medal, the highest award conferred on civilians by the Department of Defense. From 1946 to 1957, he was employed by the National Security Agency as chief of the Radio Division, then as assistant technical director of research and development, and finally as chief communications engineer. In July 1957, Mr. Dingley retired from Civil Service and joined the engineering research staff of Electronic Communications, Inc. He is a Fellow of the Institute of Radio Engineers (IRE), national vice-chairman of the IRE Professional Group on Communications Systems, a member of the National Society of Professional Engineers, Tau Beta Pi, and the Armed Forces Communications and Electronics Association. He is the author of numerous technical papers and articles and he holds over 25 U. S. and foreign patents.

Alois Hoefle (M '46), chief electrical engineer, electrical engineering department, Toledo Edison Company, Toledo, Ohio, has been transferred to the grade of Fellow in the AIEE ". . . for his contributions to the restoration of electric power in Europe while on occupational duty with the Army of the United States and for the application of higher distribution voltages to the Toledo Edison System." Mr. Hoefle was born in Munich, Germany, on November 1, 1901. He received the B.S. degree in electrical engineering and also in hydroelectric engineering from State College of Washington in 1923. After graduation he held various engineering positions with the Public Service Company of Colorado, Portsmouth Public Service Co., H. L. Doherty & Co., Toledo & Indiana R.R. Co., and the Toledo Edison Company. From 1941 to 1946, he served as Lt. Colonel in the U. S. Army. Two years of this period were spent with Supreme Headquarters Allied Expeditionary Forces in the European Theater of Operations on rehabilitation of electric power facilities. He served in England, France, Belgium, The Netherlands, Luxembourg, Switzerland, Austria, and Germany. He was member and chairman of the Quadripartite Electric Power Committee for Germany in Berlin. In 1946, he returned to the Toledo Edison Company as superintendent of the system operating department. He assumed his present position as chief electrical engineer in 1953. In 1949, Mr. Hoefle was a member of a special mission to Germany for the Department of Defense to study and report on the decartelization of the German power industry. In 1951, he spent 10 months in Washington, D. C., with the Defense Electric Power Administration. He headed the South East Region on electric power supply matters. Mr. Hoefle is a member of the Engineering Society of Toledo, Tau Beta Pi, and Edison Electric Institute Electrical System and Equipment Committee. He is a registered professional engineer in the State of Ohio and is listed in "Who's Who in Engineering." Mr. Hoefle served on the AIEE System Engineer Committee (1953-54).

William Murray Joslin (M '46), vice-president in charge of engineering, construction, and production, Commonwealth Edison Company, Chicago, Ill., has been transferred to the grade of Fellow in the AIEE ". . . for his development and inspiration of young electrical engineers and his engineering achievements in the development of a large electric utility system." Mr. Joslin was born on November 21, 1901. He received the B.S. degree in E.E. from Iowa State College in 1923, and also attended Depaul University Law School and Kent School of Law. After graduation from Iowa State in 1923, he joined the Public Service Company of Northern Illinois as an engineering inspector. In 1924, he was made an assistant in the office of vice-president in charge of electric operation, and in 1926 was given responsibility for all commercial activities in the West Chicago District of the company. He transferred to the General Office in 1927 to become educational supervisor in the industrial relations department, and in 1929 joined the office of the vice-president in charge of operations. He was made superintendent of substations in 1932, general power supervisor in 1938, and division operating superintendent in the company's Southern Division in 1939. In 1940, he transferred to the Western Division as division manager, becoming division vice-president in 1941. In 1946, Mr. Joslin transferred to the General Office as assistant to the operating vice-president. He was made manager of stations and substations in January 1951, and later in 1951, became assistant to the executive vice-president. At this time, he organized and directed the company's Nuclear Power Study Group under agreement with the Atomic Energy Commission. From 1952 to 1953, he served as assistant to the president of Commonwealth Edison Company, with which Public Service Company had been affiliated since 1937. Shortly after the Public Service Company was merged with Commonwealth Edison Company in 1953, Mr. Joslin was elected financial vice-president of Commonwealth Edison Company. He was elected to his present position, vice-president in charge of engineering, construction, power production, and power supply, early in 1955. Mr. Joslin is a member of the Western Society of Engineers, Eta Kappa Nu, and is a registered professional engineer in the State of Illinois.

Dewey D. Knowles (M '39), manager of product administration, Westinghouse Electric Corporation, Elmira, N. Y., has been transferred to the grade of Fellow in the AIEE ". . . for his contributions in research, design, and application in the field of gas-filled tubes and for his leadership in the electronic industry." Mr. Knowles was born in LaGrange, Ohio, March 14, 1899. He received the A.B. degree from Baldwin Wallace College in 1922 and the B.S. degree in E.E. from Purdue University in 1923. He joined the Westinghouse student engineering course in 1923 and later that year was employed in the Westinghouse Research Laboratories, where he was the first man assigned full time to the task of developing industrial electronic tubes and industrial tube applications. In 1930, he was made manager of the gaseous conduction section and in 1936 manager of the Electronic Section. In 1937, he left Westinghouse to become director of research and engineering for the Raytheon Company and late in 1939 returned to Westinghouse as a member of the electronic engineering staff in Bloomfield, N. J. In 1940, he was made assistant manager of the electronics engineering department and in 1941 became manager. In 1952 he was made staff assistant to the vice-president, Electronic Tube Division, and in 1954 manager of product administration. He is now tech-

nical advisor to development and production. Mr. Knowles holds approximately 80 patents on various types of electronic tubes and circuits for voltage and current regulation, speed control, synchronization, welding controls, flame controls, etc. In 1927, he was awarded the John Scott Medal for Meritorious Invention in the field of gaseous conduction tubes. Mr. Knowles is a senior member of the Institute of Radio Engineers, and a Fellow of the American Physical Society. He is the author of technical papers on electronic tubes, ignitrons, tube reliability, control circuits, etc. Mr. Knowles has made two extended trips to Europe, one in 1953 and one in 1954, to study European engineering and production practice. He served on the AIEE Electronics Committee (1945-46, 1947-48).

Donald Edward Marshall (AM '27, M'33), section manager, power tube development engineering, Westinghouse Electric Corporation, Elmira, N. Y., has been transferred to the grade of Fellow in the AIEE ". . . for basic contributions to gas type electronic tubes and ignitron rectifiers." Mr. Marshall was born in Las Vegas, N. Mex., on December 15, 1902. He received the B.S. degree in E.E. from the University of Iowa in 1925, following which he entered the Westinghouse Graduate Student Course. In 1926, he was assigned to the supply engineering department in East Pittsburgh, Pa. In 1927, he became assistant to J. F. Peters, Westinghouse consulting engineer. In 1929, he was assigned to the research department to do research on the reason for arc back in mercury arc rectifiers. Some of this work lead to the discovery of the ignitron tube. In 1930, he was sent to the California Institute of Technology on a Westinghouse scholarship to study physics. He received the M.S. degree in physics in 1932. He then returned to the Westinghouse research department and resumed development work on ignitron tubes. In 1937, he was transferred to the Westinghouse Lamp Division, Bloomfield, N. J., to complete commercial development of ignitron tubes. He was appointed section engineer in charge of gas and industrial tube development in 1939. In 1952, he moved to Elmira, N. Y., as part of the new Electron Tube Division. In 1954, he was appointed section manager of power tube development engineering, which included, in addition to gas and industrial tubes, high power vacuum tubes and microwave tubes. Mr. Marshall is a member of the American Physical Society, Tau Beta Pi, and an associate member of Sigma Xi. He has served on the Institute of Radio Engineers Subcommittee on Gas Tubes of which he is past chairman. Mr. Marshall is the author of several technical papers and holds 18 patents. He has served on the following AIEE Committees: Electronics (1946-57), and Industrial Power Rectifiers (1947-57).

John Maxian, Jr. (M '43), chief electrical engineer, North American Aviation, Inc., Los Angeles, Calif., has been transferred to the grade of Fellow in the AIEE ". . . for pioneering work in the application of electrical engineering principles to the design and development of electrical systems in aircraft." Mr. Maxian was born in Wheeling, W. Va., on September 24, 1905. After graduating from the Linsly Institute of Technology in 1928, he was employed by North American Aviation, Inc. During the period 1928-36, he worked in the instrument, radio, and general electrical fields as related to aircraft. In 1936, he was appointed to the position which he holds at the present time, chief electrical engineer. Some of the items pioneered under the direction of Mr. Maxian were: electrical pressurization control for the first pressurized military aircraft; electrical and fire control provisions for the first aircraft 75 mm cannon installation; jet engine electrical control system which simplified pilot operations through the use of electronic computers to co-ordinate four jet engine control parameters with the aircraft operating temperature, air density, and air speed; radar navigation system for fighter aircraft which materially advanced all-weather navigation; and radar fire control system for gun and rocket aiming and firing for all-weather interceptor aircraft. Fully automatic from take-off, this system provided automatic tracking of the target and automatic firing within ballistic range. In 1951, he was selected jointly by the U. S. Air Force and the Bureau of Aeronautics to serve as a member of the U. S. Advisory Staff for Electrical System. Mr. Maxian is a member of the Aircraft Electrical Society and the American Ordinance Society and is a registered professional engineer in the State of California. He is active in the Los Angeles Section of the AIEE and served as chairman of the Aircraft Division of that Section in 1943. He has served on the AIEE Air Transportation Committee (1944-46, 1951-57).

Ambrose John Petzinger (AM '36, M '44), manager, instrument department, Westinghouse Electric Corporation, Newark, N. J., has been transferred to the grade of Fellow in the AIEE ". . . for original developments in the field of electrical measurements." Mr. Petzinger was born in Paterson, N. J., on September 19, 1913. He received the B.S. degree in engineering in 1934 and the E.E. degree in 1935, both from Princeton University. Mr. Petzinger entered the Westinghouse Electric Corporation Graduate Student Course, East Pittsburgh, Pa., in 1935. He transferred to Newark, N. J., in 1936 as design engineer in the Westinghouse Meter Division. He became senior design engineer in 1943, supervising engineer in 1952, and engineering section manager in 1954. Since 1955, he has been manager of the instrument department, Meter Division, responsible for sales, order service, engineering, and manufacture of electrical instruments. Mr. Petzinger's experience has included the development of (1) the first combination polyphase watt-hour and thermal watt demand meter, (2) the first combination single-phase watt-hour and thermal ampere demand meter, (3) the first and only combination polyphase watt-hour and thermal ampere demand meter, and (4) the first and only combination polyphase watt-hour and thermal kva demand meter. Mr. Petzinger has been granted 13 patents in the field of metering and 10 patent applications are pending at present. One of the patents was recognized by the Westinghouse Outstanding Disclosure Award. Mr. Petzinger has given talks before various meter engineers' associations in all parts of the country on design and application of meters and is the author of several technical papers published in AIEE *Transactions*. In 1943-44, he taught two terms of Fundamental Radio in evening sessions at Rutgers University. He is the National Electrical Manufacturers Association (NEMA) representative on the American Standards Association (ASA) Subcommittee C39.2 on Electrical Measuring Instruments. Mr. Petzinger has served on the AIEE Instruments and Measurements Committee (1954-55), and Indicating and Integrating Instruments Committee (1956-57).

Robert Vincent Shepherd (AM '36, M '43), manager, a-c motor and generator engineering, large motor and generator department, General Electric Company, Schenectady, N. Y., has been transferred to the grade of Fellow in the AIEE ". . . for his contributions to the design of large motors and generators." Mr. Shepherd was born in Seneca, Kans., on September 29, 1912. He received the B.S. degree in E.E. from the University of Illinois in 1935. He joined the General Electric Company in October 1935 as test engineer. From 1937 to 1945, he was design engineer in the large motor and generator department. In 1945, he was appointed manager of the subsection designing large low-speed synchronous motors and generators for industrial power purposes. In 1950, he was appointed manager of the Synchronous Motor and Generator Subsection. Mr. Shepherd has contributed to the theory, calculation of performance characteristics, and to the mechanical and electrical design of large conventional and special a-c motors and generators. He is the author of several technical papers and a book, co-authored with H. D. Snively, on a-c motors. Mr. Shepherd has been active in promoting the use of computers for electrical design calculations. He has also been active in the field of teaching of electrical machine theory and design. Mr. Shepherd is a registered professional engineer in the State of New York. He is a member of the National Society of Professional Engineers, New York State Society of Professional Engineers, Schenectady General Electric Engineers' Association, Sigma Tau, and Eta Kappa Nu. He was chairman of the Schenectady Engineering Council in 1950. Mr. Shepherd has been active in the Schenectady Section of AIEE, serving as treasurer in 1944 and in 1945, and as chairman, 1948. He has been a member of the following AIEE Committees: Rotating Machinery (1948-49), Section (1948-50), and Registration of Engineers (1951-57).

Howard Donald Snively (AM '35, M '44), manager, advance product engineering, large motor and generator department, General Electric Company, Schenectady, N. Y., has been transferred to the grade of Fellow in the AIEE ". . . for his contributions to the design and development

A. J. Petzinger

R. V. Shepherd

H. D. Snively

H. C. Steiner

G. C. Tenney

of a-c and d-c machinery." Mr. Snively was born in Canton, Ohio, on January 30, 1911. He received the B.S. degree in E.E. from the University of Cincinnati in 1934. Following this, he was employed as a test engineer by the General Electric Company. Mr. Snively's engineering achievements include pioneering work, in 1936, in the calculation of stresses and deflections of rotor parts on synchronous machinery and steam turbines, and development work on stress analysis determinations by photo-elastic models. From 1939 to 1941, he was responsible for the design and test of large a-c machines including 60,000 kva generators, and was responsible for performing the guarantee tests on the Bonneville Dam generators. From 1942 to 1949, he was responsible for the design of special a-c machinery. During this period, he designed marine synchronous propulsion motors, sine wave generators, pulse generators, short circuit generators, booster generators, welding generators, high-frequency generators, and many others. From 1949 to 1951, he was responsible for the design of large d-c machinery which included large steel mill motors, d-c marine propulsion generators and motors, and main and pilot exciters for steam-turbine and hydroturbine generators. From 1952 to the present, he has been manager of the advance development engineering subsection of the large motor and generator department, with responsibility for advance development relating to current products and evaluation of possible new products. Mr. Snively is the author of numerous technical papers and a co-author with R. V. Shepherd of a textbook on a-c motors and has been active in teaching engineering courses. Mr. Snively is a member of the National Society of Professional Engineers, Schenectady General Electric Engineers Association, Engineers Club of Cincinnati, American Society of Mechanical Engineers, Sigma Xi, Tau Beta Pi, and Eta Kappa Nu. He is a registered professional engineer in the State of New York. Mr. Snively has served on the AIEE Rotating Machinery Committee (1954-57).

Harry Carlton Steiner (AM '32, M '44), consulting engineer, power tube department, General Electric Company, Schenectady, N. Y., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to the development and application of mercury vapor rectifier tubes." Mr. Steiner was born in Larned, Kans., on October 5, 1902. He received the B.S. degree in E.E. from the University of Kansas in 1926, and also attended Union College. He entered the General Electric Test Course in 1926. From 1927 to 1930, he worked in the Research Laboratory on the development of high-voltage hot-cathode single-anode mercury vapor rectifier tubes (Phanotrons) for radio transmitter service. From 1930 to 1935, in vacuum tube engineering, he was concerned with the development of thyratron tubes, following the basic ideas of Dr. A. W. Hull, for variable speed motor control, lighting control, and other industrial applications. From 1935 to 1946, he was leader of a group working on the development of the first sealed, stainless-steel-jacketed ignitron tubes for resistance welding control and power rectifiers for industrial service. From 1946 to 1954, he was design engineer in charge of the engineering sections responsible for the design and application of thyratron and ignitron tubes. He was manager, from 1954 to 1956, of the Design Engineering Subsection dealing with the design of ignitron and mercury-arc rectifier equipment and ignitron tubes and tanks for rectifier and welding control service. He has been consulting engineer on gas and special tubes since September 1956. Mr. Steiner is the author of several technical papers. He is a registered professional engineer in the State of New York, and is a member of the New York Society of Professional Engineers, American Ceramic Society, Tau Beta Pi, and Sigma Tau. He has served on the following AIEE Committees: Industrial Power Rectifiers (1947-57); Electronics (1947-57, chairman 1953-55); and Science and Electronics Division (1953-57). He was co-chairman of the AIEE Conference on Industrial Application of Electron Tubes in 1949.

George C. Tenney (AM '35, M '42), regional vice-president, McGraw-Hill Publishing Company, Inc., San Francisco, Calif., has been transferred to the grade of Fellow in the AIEE ". . . for important contributions to the advancement of engineering knowledge." Mr. Tenney was born in Provo, Utah, on July 13, 1898. He received his technical education as a student in the department of electrical engineering, College of Mechanics, University of California. In 1920, he became an editorial staff writer on the *San Francisco Chronicle*. In 1921, he joined McGraw-Hill Publishing Company, Inc., as associate editor, *Journal of Electricity*, becoming managing editor in 1923. From 1930 to 1956, he served as editor of *Electrical West*. He has been a director of McGraw-Hill Company of California since 1926, publisher of *Electrical West* since 1930, president of McGraw-Hill Company of California since 1942, and regional vice-president of McGraw-Hill Publishing Company, Inc., since 1946. From 1947 to 1948, he was acting editor of *Electrical World*. He has been Pacific Coast editor of *Nucleonics* since 1950. Mr. Tenney served as president of the Electric Club of San Francisco, 1935; president of the Pacific Coast Electrical Association, 1942-43, and director 1930-56; and director of the San Francisco Engineer's Club, 1938-39. He has been active in the San Francisco Chamber of Commerce as director, 1945-48; chairman of the Aviation Committee, 1946-48; chairman of the Electronics Section Industrial Development Committee, 1947; and vice-president, 1948. He has been chairman of the University of California Engineering Advisory Council since 1947. Mr. Tenney has been active in the San Francisco Section of AIEE, serving as secretary, 1942; vice-chairman, 1943; and as chairman, 1944. He was general chairman of the 1949 AIEE Pacific General Meeting, and was vice-president of AIEE District No. 8, 1953-55. He has served on the following AIEE Committees: Domesic and Commercial Applications (1944-51), and Publications (1949-53).

AIEE PERSONALITIES

D. K. Blake (AM '23, F '51), manager, power distribution engineering, engineering planning and development, General Electric Company, and editor-in-chief of *Distribution* magazine, retired October 1, 1957. Mr. Blake was born in Monroe, La., on September 19, 1896. He began his career in 1916 as a substation operator for the Public Service Company of Northern Illinois. In 1918, he joined the Gen-

eral Electric Company as a test engineer, transferring to the engineering department in 1920. In 1923, he became General Electric's first distribution engineer, and in 1931 was the recipient of the Coffin Award for development of network protector phasing relay. In 1939, he aided in the launching of *Distribution* magazine. He was elected to Sigma Tau in 1950. Recognized as one of the foremost systems engineers in the country, Mr. Blake has been an active AIEE member, serving on the following committees: Transmission and Distribution (1932-52, 1954-57); Domestic and Commercial Applications (1942-49); and System Engineering (1952-53).

H. E. Webb (AM '54), assistant to the works manager of the Time Equipment Division, International Business Machines Corporation (IBM), has been appointed project manager of the time punch assembly and the autopoint computer assembly departments in IBM's Endicott (N. Y.) Plant.

G. G. Hoberg (AM '52), associate director of engineering, Burroughs Corporation, has been appointed to the newly created post of manager, special data-processing equipment engineering, Radio Corporation of America. Mr. Hoberg has served on the AIEE Computing Devices Committee (1952-55, 1956-57).

E. R. Schoch, Jr. (AM '52), associate engineer, International Business Machines Corporation (IBM), has been promoted to staff engineer in the special product engineering department of the IBM Product Development Laboratory at Poughkeepsie, N. Y., where he is now assigned to the design of optional and special features on an IBM transistorized calculator.

P. G. See (AM '44), agency sales manager for the Nelson Electric Manufacturing Company, has joined the staff of the Randolph Engineering Corporation in Los Angeles, Calif.

R. H. Smith (AM '50), assistant manager, Washington (D. C.) Office, American Machine & Foundry Company, has been appointed technical manager for present product lines of the company's Engineering Division. Mr. Smith served on the AIEE General Industry Applications Committee (1948-51).

W. C. Bullock (AM '51), supervisory engineer, Magnetic Device Section, Westinghouse Electric Corporation, has joined the engineering staff of G-L Electronics, Camden, N. J.

W. G. Fockler (AM '45), assistant engineering manager of the Technical Products Division, Allen B. Du Mont Laboratories, Inc., Clifton, N. J., has been named manager of technical products engineering.

W. L. Healy (AM '51, M '57), specialist, Switchgear and Control Division, General Electric Company, Philadelphia, Pa., was selected by the Standards Engineers Society to receive a Fellowship award. Mr. Healy served as president of the society, 1953-54.

C. W. Hansen (AM '50), project engineer, apparatus engineering department, X-Ray Division, General Electric Company, Milwaukee, Wis., has been appointed chief engineer of the Industrial Products Division of Tracerlab, Waltham, Mass.

Glenn Bates (AM '40, M '48), switchgear engineer, Westinghouse Electric Corporation, Seattle, Wash., has been appointed Pacific Coast switchgear supervisor. Mr. Bates has served on the AIEE Industrial Power Systems Committee (1952-57).

OBITUARIES

Gerard Swope (AM '99, F '22, Member for Life), retired, former president of the General Electric Company, died recently at the age of 84. Mr. Swope was born in St. Louis, Mo., on December 1, 1872. He received the B.S. degree in E.E. from Massachusetts Institute of Technology in 1895, and received the honorary doctor of science degree from Rutgers University in 1923, Union College in 1924, Washington University in 1932; the doctor of laws degree from Colgate University in 1927; and doctor of engineering degree from Stevens Institute of Technology in 1929. He began his engineering career as a helper at General Electric, Chicago, Ill., in 1893. In 1895, he was employed by Western Electric Company, Chicago, as a design engineer, becoming manager of the St. Louis, Mo., office in 1899. In 1906, he returned to Chicago as general manager of the power apparatus engineering department and in 1908 he went to New York, N. Y., as general sales manager, becoming vice-president and director of the company in 1913. During World War I, he was a member of the general staff of the United States Army. In 1919, he was made president of the International General Electric Company, New York, N. Y., and was in charge of companies abroad engaged in manufacturing, engineering, and commercial activities. He became president of the General Electric Company in 1922. Following his retirement in 1940, he continued to serve as honorary president, resigning from that position in 1944. Mr. Swope was decorated by the Emperor of Japan with the Order of the Rising Sun (1917), was named Chevalier of the Legion of Honor by the French Government, and was awarded the United States Army Distinguished Service Medal, and the gold medal of the National Institute of Social Sciences (1932). He was the recipient of the Hoover Gold Medal in 1942.

Arthur E. Bond (AM '54), chief planning engineer for Pacific Power & Light Company (PP&L), Portland, Oreg., died recently. He was 61. Mr. Bond was born August 21, 1896, in Holland, Mich. Following graduation from Washington State College in 1922 with a degree in electrical engineering, he joined PP&L as an engineering department clerk. In 1926, he became division engineer for the Phoenix Utility Company in Miami, Fla., then went to South America in 1928 as transmission engineer for Emprezas Electricas Brasileiras, a utility firm in Brazil. He rejoined PP&L's engineering staff in 1933 and became Yakima division engineer in 1937. He returned to the Portland office as assistant distribution engineer in 1941, advancing to chief design engineer in 1943. Mr. Bond was promoted to planning engineer in 1949 and to chief planning engineer in 1951.

David Melville Moncrief, Jr. (AFFIL '52), assistant commercial manager of The Hawaiian Electric Company, Honolulu, Hawaii, died recently at the age of 46. Mr. Moncrief was born July 30, 1911, in Honolulu. He received the A.B. degree in economics in 1932 from Stanford University. He had been with The Hawaiian Electric Company since 1932.

John Joseph Gilbert (AM '13, M '29, F '51, Member for Life), ocean cable engineer, Simplex Wire & Cable Co., Newington,

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N. H., died recently. Mr. Gilbert was born in Philadelphia, Pa., on August 31, 1887. He received the A.B. degree from the University of Pennsylvania in 1909. He also attended Harvard University, the University of Chicago, and Armour Institute, from which he received the E.E. degree in 1915. From 1912 to 1917, he was an instructor in electrical engineering at Armour Institute, Chicago, Ill. He served as a Captain in the U. S. Signal Corps from 1917 to 1919, after which he was employed by the Western Electric Company and the Bell Telephone Laboratories. Mr. Gilbert was an expert in the field of submarine cable design. He was the recipient of an Army–Navy Certificate of Appreciation for outstanding contributions to the Office of Scientific Research and Development during World War II. Mr. Gilbert was a senior member of the Institute of Radio Engineers and a Fellow of the American Association for the Advancement of Science.

MEMBERSHIP

Recommended for Transfer

The Board of Examiners at its meeting of November 21, 1957, recommended the following applications for transfer. Any objection to these transfers should be filed at once with the Secretary of the Institute. A statement of valid reasons for such objections must be furnished and will be treated as confidential.

To Grade of Member

Anderson, J. E., senior engineer, The Metropolitan District of Southern California, Los Angeles, Calif.

Anderson, R. G., electrical engineer, Wagner Electric Corp., St. Louis, Mo.

Appleton, E. B., electrical engineer, Navy Dept., D.P.W.O., U.S. Naval Shipyard, Pearl Harbor, Hawaii

Asp, E. G., system engineer, Bonneville Power Administration, Seattle, Wash.

Baldwin, M. S., consulting & application engineer, Westinghouse Electric Corp., Cleveland, Ohio

Bates, J. F., assistant electrical engineer, electrical dept., Gibbs & Hill, Inc., New York, N.Y.

Bauer, R. E., assistant engineer, Consolidated Edison Co. of N.Y., Inc., New York, N.Y.

Bersbach, A. J., chief, test equipment & systems planning dept., Hughes Aircraft Co., Tucson, Ariz.

Camburn, R. D., engineer, systems studies dept., Commonwealth Associates, Inc., Jackson, Mich.

Carlson, H. W., Jr., engineer, Philadelphia Electric Co., Philadelphia, Pa.

Carpenter, H., chief engineer, power & engineering dept., Minnesota Power & Light Co., Duluth, Minn.

Carroll, J. E., research engineer, Lincoln Electric Co., Cleveland, Ohio

Cloer, J. B., Jr., power representative, Toledo Edison Co., Toledo, Ohio

Covington, J. K., owner, consulting electrical engineer, Abilene, Texas

Dahl, O. F., electrical engineer, Austin Associates, Seattle, Wash.

Dinkel, J. W., electrical engineer, Taylor Elevator Co., Cleveland, Ohio

Drinkhouse, W. H., electrical engineer, Louis W. Moxey 3rd, Consulting Electrical Engineer, Philadelphia, Pa.

Duchynski, R. H., electrical engineer, engineering dept., Gilbert Associates, Inc., Reading, Pa.

Duncan, G. I., insulating materials engineer, special transformer dept., General Electric Co., Fort Wayne, Ind.

Elmore, W. A., consulting & application engineer, Westinghouse Electric Corp., Seattle, Wash.

Erwin, D. B., department chief, Hawthorne Station, Western Electric Co., Chicago, Ill.

Freericks, Lambert, project engineer, N. Y. Telephone Co., New York, N.Y.

Graves, H. K., supervisory electrical engineer, Material Laboratory, Navy Dept., N.Y. Naval Shipyard, Brooklyn, N.Y.

Hancock, S. J., electrical design engineer, Westinghouse Electric Corp., Lima, Ohio

Harlow, W. G., manager engineering administration, General Electric Co., Philadelphia, Pa.

Hicks, K. L., electrical engineer, electrical engineering dept., Sargent & Lundy, Chicago, Ill.

Jennings, J. J., plant engineer, General Electric Co., Louisville, Ky.

Johnson, J. C., equipment design engineer, Radio Corporation of America, Lancaster, Pa.

Keiler, H. G., power superintendent, power dept., ALCOA, Point Comfort, Texas

Lanham, L. E., staff member, Los Alamos Scientific Laboratory, Los Alamos, N.M.

Lundquist, R. W., T & D engineer, operating dept., Iowa Public Service Co., Sioux City, Iowa

Massingill, J. A., supervisor-electrical design & production engineering, large steam turbine-generator dept., General Electric Co., Schenectady, N.Y.

Matthan, K., technical engineer, Bombay Electric Supply & Transport Undertaking, Bombay, India

McCann, C. H., Jr., electrical engineer, Goodyear Atomic Corp., Portsmouth, Ohio

McClintock, D. C., electrical engineer, Sargent & Lundy, Engineers, Chicago, Ill.

Mele, F., electrical engineer, electrical dept., Gibbs & Hill, Inc., New York, N.Y.

Meswarp, H. W., supervising electrical engineer, Gibbs & Hill, Inc., New York, N.Y.

Meyer, O. R., supervising engineer, Westinghouse Electric Corp., Bettis Atomic Power Div., Pittsburgh, Pa.

Mohler, R. D., project engineer, applied research dept., Motorola, Inc., Chicago, Ill.

Munson, W. A., electric utility engineer, Westinghouse Electric Corp., East Pittsburgh, Pa.

Opeka, F., supervisory airways engineer, Civil Aeronautics Administration, Dept. of Commerce, Washington, D.C.

Orszula, N. R., electrical designer, electrical dept., Vern E. Alden Co., Chicago, Ill.

Paul, R. A., personnel development engineer, General Electric Co., capacitor dept., Hudson Falls, N.Y.

Poehler, H. A., electrical engineer, General Precision Labs., Pleasantville, N.Y.

Ricketts, L. W., Jr., instructor, University of Illinois, electrical engineering dept., Urbana, Ill.

Roomy, J. E., sales engineer, General Electric Co., St. Louis, Mo.

Rowe, J. F., engineer, engineering dept., Minnesota Power & Light Co., Duluth, Minn.

Ruvle, H. C., Jr., engineer, General Electric Co., Dallas, Texas

Salzer, J. M., director of systems, The Magnavox Co., Los Angeles, Calif.

Schaufelberger, D. E., system planning engineer, engineering dept., Consumers Public Power District, Lincoln, Nebr.

Shotts, J. E., design engineer, I-T-E Circuit Breaker Co., R.&I.E. Equipment Div., Greensburg, Pa.

Sprague, A. T., Jr., associate professor, electrical engineering, Alabama Polytechnic Inst., Auburn, Ala.

Strasser, R. A., technical consultant, Aerial Reconaissance Lab., Wright Air Development Center, Wright-Patterson Air Force Base, Ohio

Stratford, R. P., application engineer, General Electric Co., Schenectady, N.Y.

Tallman, R. J., manager, Wenatchee District Office, Bonneville Power Administration, Wenatchee, Wash.

Trunk, E. G., senior development engineer, Servo Corp. of America, New Hyde Park, N.Y.

Warren, C. A., engineer, relay & control engineering dept., Oklahoma Gas & Electric Co., Oklahoma City, Okla.

West, R. R., senior project engineer, engineering dept., Duquesne Light, Pittsburgh, Pa.

58 to grade of Member

Applications for Election

Applications for admission or re-election to Institute membership in the grade of Member have been received from the following candidates, and any member objecting to election should so notify the Secretary before January 25, 1958, or March 25, 1958, if the applicant resides outside of the United States, Canada, or Mexico.

To Grade of Member

Atrazkiewicz, B., squad leader, Anaconda Co., New York, N.Y.

Becker, W. R., superintendent & engineer, City of Chicago, Chicago, Ill.

Buser, W., engineer in charge of apparatus dept., Brown Boveri (Canada) Ltd., St. John, P.Q., Canada

Cessna, S. R., supervisor-engineering administration & personnel development dept., General Electric Co., Hudson Falls, N.Y.

Cook, T. J., transmission staff engineer, Southern Bell Tel. & Tel. Co., Atlanta, Ga.

Couture, C., Jr., assistant administrative officer, Charleston Naval Shipyard, Charleston, S.C.

Estes, O. T., chief, Electrical Engineering Section, U.S. Coast Guard, Washington, D.C.

Flynn, E. J., manager-chemistry & insulation, General Electric Co., Schenectady, N.Y.

Frankel, P., research engineer, Lockheed Aircraft Corp., Factory A-1, Burbank, Calif.

Giles, R. H., division engineer, Stanley Warner Management Corp., Cleveland, Ohio

Gindroz, A., relay engineer, Northern Indiana Public Service Co., Hammond, Ind.

Green, L. L., manager of motor & transformer shop, Interstate Electric Corp., Tulsa, Okla.

Kaleda, G. M., supervisor, Electrical Design Div., Philadelphia Naval Shipyard, Philadelphia, Pa.

Kitchen, W. H., Jr., chief engineer, Mathers & Haldenby, Toronto, Ont., Canada

Larsen, M. J., head professor, electrical engineering dept., University of Florida, Gainesville, Fla.

McIntosh, C. D., Jr., assistant superintendent & resident engineer, City of Lakeland, Light & Water Dept., Lakeland, Fla.

Merriman, P. H., electrical engineer, Du Pont, Chattanooga, Tenn.

Muir, R. L., electrical engineer, Sargent & Lundy, Chicago, Ill.

Otis, C. F., engineering section manager, Philco Corp., Philadelphia, Pa.

Paul, J. C., product engineer, General Electric Co., Erie, Pa.

Paulisen, H., supervisor-electronic engineers, Federal Communications Commission, New York, N.Y.

Perkul, S. S., electrical engineer-designer, Dingle-Clark Co., Cleveland, Ohio

Pfeifer, B. F., president & general manager, Lumen, Inc., Joliet, Ill.

Roberts, T. D., Jr., sales engineer, Westinghouse Electric Corp., Atlanta, Ga.

Safdie, N., senior designer, Ebasco Services, Inc., New York, N.Y.

Scanlan, J., electrical engineer, A.C.F. Industries, New York, N.Y.

Schaftenaar, G.A.H., town electric engineer, Town Council, Graaf-Reinet, Cape Province, South Africa

Shinn, E. S., head electrical engineer, International Engineering Co., San Francisco, Calif.

Tellier, R. A., division chief, research dept., Electricite de France, Paris, France

Thompson, H. O., senior electrical engineer, United Illuminating Co., New Haven, Conn.

Thurston, J. N., head-electrical engineering dept., Clemson A & M College, Clemson, S.C.

Vincent, G. D., director, standard cell dept., Eppley Lab., Newport, R.I.

Williams, W. T., electrical engineer, U. S. Bureau of Reclamation, Denver, Colo.

Woods, J. L., project design engineer, Convair, Fort Worth, Texas

Wristen, C. E., analytical & test engineer, Columbus & Southern Ohio Electric Co., Columbus, Ohio

35 to grade of Member

ELECTRICAL ENGINEERING EDUCATION

AIEE in University of Santa Clara

THE STUDENT BRANCH of the AIEE at the University of Santa Clara, Santa Clara, Calif., was granted its charter October 15, 1926. A joint AIEE-Institute of Radio Engineers (IRE) Student Branch was established November 13, 1956.

Meetings are held twice a month with either a guest speaker or a film on some pertinent phase of electrical engineering. Inasmuch as the University is located in the San Francisco Bay area, there are many opportunities for interesting and educational field trips to industrial manufacturing plants and laboratories.

On the University campus is located the eighth of the early California missions *(right)*. Originally founded by Father de la Pena and the Spanish Franciscans in 1777, it became the University of Santa Clara in 1851. It was the first college west of the Mississippi River.

The University's College of Engineering was founded in 1912 and has grown rapidly in the last few years. Plans are being made for the construction of a new engineering building in order to meet this increased enrollment.

Canada's First Subcritical Atomic Reactor for Educational Purposes

TO EDUCATE increasing numbers of young Canadians for the atomic age, Canada's first subcritical atomic reactor for educational purposes will shortly be installed in the faculty of applied science and engineering at the University of Toronto.

Designed by the nuclear engineering department of General Dynamics Corporation's Montreal subsidiary, Canadair Limited, the reactor is now under construction at Canadair and, upon completion early in 1958, will be installed in the University's Wallberg Building.

Although incapable of initiating chain reaction, the new reactor will otherwise be similar to operating reactors. In addition, special electronic equipment will be provided in order that students can see actual operating conditions simulated and face problems that might arise in working with a full-scale reactor.

The new project marks the first entry of the faculty of applied science into the nuclear physics field and fills the gap between this faculty and the department of physics, which has already launched a concurrent program in nuclear physics.

The entire equipment will cost $439,000 with heavy water accounting for $200,000 of this. In addition, Eldorado Mining and Refining will supply on loan, three tons of uranium worth $100,000 for the reactor, and radium beryllium neutron source will be obtained from the Commercial Products Division of Atomic Energy of Canada Limited.

A reactor capable of reaching critical condition does so because it contains enough uranium to sustain chain reaction. Neutrons bombard the uranium atoms which split providing additional neutrons which in turn bombard other uranium atoms. Thus, the process becomes a self perpetuating chain reaction. If, however, the uranium mass is too small, the neutrons tend to fly off into space and cannot set up chain reaction. The reactor is being engineered so that it will not contain enough uranium to cause chain reaction and is, therefore, called a subcritical reactor since the fission process is only sustained by the neutrons supplied by the source.

Its operation will be as safe as operations carried out in the ordinary physical chemical and engineering laboratories of the University. There are several different types of reactors; some use enriched uranium, others natural uranium and graphite. This reactor will be of the natural uranium heavy-water type because from the start it has been Canada's policy to build such reactors. The reactor will consist essentially of a cadmium-clad stainless steel tank, five feet in diameter and six feet high, containing 820 gallons of heavy water into which can be lowered natural uranium rods of one inch diameter and up to a total weight of three tons. The counting equipment required for experimental work will be in a special room adjacent to the reactor. An electronic simulator being built by Minneapolis-Honeywell is being installed in a separate room and this equipment will make it possible for students to simulate, so far as controls are concerned, the action of a large-scale reactor that can go critical. It is intended also to establish a laboratory for radioactive tracer work, making use of the counting equipment also required for the reactor. The entire program will be in effect early in 1958.

Electrical Engineering Education

College–Industry Conference To Be Held January 30-31, 1958

"New Concepts in the Education and Development of Technical Manpower" is the theme of the 1958 College–Industry Conference of the American Society for Engineering Education (ASEE) which is to be held at the University of Michigan January 30-31.

Four speakers are scheduled to present the new concepts arising from current research: Paul Reinert, president of St. Louis University, will speak on "New Concepts in Education from the President's Committee on Education Beyond High School"; A. A. Kucher, vice-president of engineering and research for the Ford Motor Company, will have "New Concepts in Engineering" as his topic; D. C. Pelz, University of Michigan survey research center, "New Concepts Useful in Motivating Engineering and Technical Personnel"; Lee Danielson or J. W. Riegel, University of Michigan bureau of industrial relations, "New Management Concepts Obtained through Interviews with Employed Engineers and Technicians."

Four additional speakers will describe recently inaugurated programs designed by their companies to utilize "New Concepts of Professional Development"—W. R. Collings, president of Dow-Corning Corporation; E. E. Sivacek, chief engineer, King-Seeley Corporation; A. L. Bain, superintendent of engineering training for Western Electric Company; L. V. French, director of engineering personnel for Whirlpool-Seeger Corporation. These reports hold many implications for education as well as for employers of engineers. Several other features are in the process of being arranged.

Registration will be held from 8:30 to 10:00 a.m., January 30. Those attending will be welcomed by William Stirton, vice-president of the University of Michigan. The conference will adjourn at 2:00 p.m. Friday, January 31.

For additional information contact the University of Michigan College of Engineering, 255 West Engineering Building, Ann Arbor, Mich.; telephone NOrmandy 3-1511, Extension 2655.

Science Professors Benefit from ORINS Research Program

More than 500 professors from 31 states and the District of Columbia are now lecturing to their science classes on 103 college campuses with a first-hand knowledge of developments in the nation's atomic energy program, as the result of a special program which is co-ordinated for the United States Atomic Energy Commission (AEC) by the Oak Ridge Institute of Nuclear Studies (ORINS), Oak Ridge, Tenn. ORINS is a nonprofit educational corporation of 36 southern universities.

Most of the faculty members who participate in the Oak Ridge Research Participation Program do their research at Oak Ridge National Laboratory (ORNL), which is operated for the AEC by Union Carbide Nuclear Company.

A new brochure describes how the program enables college science faculty members to spend from three months to a year conducting research in Oak Ridge atomic energy installations.

The activity, in less than 10 years, has provided 561 teachers with the opportunity of participating directly in new developments in the field of nuclear energy. The program, in the opinion of ORINS, ORNL, and AEC officials, has proved of exceptional mutual benefit to the co-operating installation, to the university from which the scientist comes, and to the scientist himself.

This year, for the first time, a limited number of appointments are available for research participation at the AEC Savannah River Plant at Aiken, S. C. This arrangement is the result of a series of discussions between representatives of the AEC, the Southern Regional Education Board, the Regional Advisory Council on Nuclear Energy, and ORINS.

Because of the nature of academic-year appointments, most research participants go to Oak Ridge during the three summer months. There are, however, opportunities for appointments up to one year. The research participant draws the equivalent of his regular university salary while in Oak Ridge.

Copies of the newly issued brochure describing Oak Ridge research participation are available on request from the University Relations Division, Oak Ridge Institute of Nuclear Studies, P. O. Box 117, Oak Ridge, Tenn.

Armco Civil Engineering Scholarship Program Announced

A $15,000 yearly civil engineering scholarship program under the supervision of the National Society of Professional Engineers (NSPE) has been established by Armco Drainage & Metal Products.

Approval of the project was given by the NSPE Board of Directors at the group's recent fall meeting in Bismarck, N. Dak.

In accepting the Armco scholarship program, the Board also gave approval to a policy authorizing the NSPE to solicit and enter into agreements with associations, corporations, foundations, or individuals desiring to make scholarship and fellowship grants in the engineering field. Funds for the first scholarship program will be made available by the Armco Foundation, Inc., of Middletown, Ohio.

The program involves the establishment of five $3,000 civil engineering scholarships, to be awarded annually under the supervision of the NSPE. Each scholarship will provide a stipend of $750 per year for recipients engaged in a 4-year civil engineering curriculum.

Applicants must have the following qualifications: (1) actual need for substantial financial aid to attend college; (2) a high school record which, at the time of application, indicates that the student applying is qualified to handle college work; (3) graduation from high school during the year of application for a scholarship; and (4) a firm decision to enroll in and continue the study of civil engineering at an accredited college or university.

JESSI Aids Students In Choosing Future Careers

Future scientists and engineers for the nation's great industrial empire will sit down together in June 1958 at several colleges and universities to learn the whys and hows of this complex world.

Next September they will be juniors and seniors in high school. A few years hence they could be white-coated research chemists, steady-handed engineering draftsmen, or high-salaried corporation officials.

The occasion will be the annual two-week Junior Engineers' and Scientists' Summer Institute (JESSI), sponsored by Scientists of Tomorrow, a nonprofit corporation of Portland, Oreg.

Sole objective of the conference is to join the resources of schools, colleges, and universities with those of business and industry to bring to American youth an understanding of the scientific and technical areas of endeavor.

These teenagers—just starting on the road to a career—will be in the hands of the top faculty members of the host institution. They will attend classes, hear lectures, see demonstrations, and join in discussions to learn about all phases of science and engineering.

For those who have chosen careers in these fields, JESSI shows them what they can expect in their college studies and what industry can provide them in the way of employment. JESSI is not pushing youth into science or engineering. For those who are undecided about their careers, JESSI explores the pros and cons of becoming scientists or engineers.

"JESSI gave me an insight into all of the fields in which I was interested and will be of great value in determining a vocation," said Steve Pierce of Clarksburg, Calif., who attended a JESSI conference during the summer of 1957 at the University of Nevada. Other participants in the four separate JESSI conferences were equally enthusiastic.

Because JESSI is nonprofit, it must depend on contributions to finance it. Only when the contributions are tallied can JESSI move forward on its program for 1958.

Officials of JESSI believe these summer sessions reward industry by setting up a potential technical manpower pool from which industrial executives may draw in the near future. For this reason, JESSI hopes, in return, that industry will help support the conferences. In fact, except

for small contributions from participating students who can pay, all funds for JESSI must come from business and industry.

In the past two years, Scientists of Tomorrow has sponsored five sessions—one in 1956 and four in 1957—at specially selected colleges and universities in the United States. It is hoped that at least seven may be held next summer. Perhaps there can be more if contributions, which are tax-free and determine the number, are generous. Industry only can determine the amount of the contributions which it is willing to make toward its own future.

Pratt Offers Graduate Nuclear Engineering Program

The chemical engineering department of the Engineering School of Pratt Institute currently is offering a graduate program in nuclear engineering, under the direction of A. H. Cooper, department chairman. The introductory course elucidates basic principles of nuclear technology, including laws of radiochemistry, atomic structure, nuclear reactions, and release of energy. Students will confront engineering problems of nuclear reactors, isotope processing, production of radioactive materials, fuels and wastes, and industrial applications of atomic energy. Subsequent courses will expand on the following aspects of nuclear technology, devoting one complete course to each: nuclear engineering, nuclear reactor theory, reactor engineering design, and nuclear process engineering. These courses will be offered again, day and evening, during the school term beginning February 1958.

General Electric Fellowship Grants

Under fellowship grants totaling almost $350,000 from the General Electric (GE) Educational and Charitable Fund, 88 of the nation's outstanding college graduates are pursuing their studies toward doctoral degrees.

Of the pre-doctoral fellowships, 34 were offered on a competitive basis and 54 were assigned to specific educational institutions which nominated the students in specific fields.

Stipends for the students range from $1,750 to $2,500 per annum, depending upon marital status and number of dependents. In addition, tuition and fees are paid and an unrestricted grant of $1,000 is made to the institution which the student attends.

The fields of study include the physical sciences, engineering, industrial management, arts and science, graduate law, business, ceramics, mathematics, economics, psychology, sociology, political science, and public administration.

The fellowship grants are part of approximately $1.5 million in aid to higher education which GE and the GE Educational and Charitable Fund are expending this year.

In addition to the fellowships, the aid includes 50 scholarship awards, 300 summer fellowships for secondary school science and mathematics teachers, help in equipping laboratories to about 50 colleges and universities, and approximately 300 educational loans to employees. In addition, the Educational and Charitable Fund annually matches approximately 5,000 employee gifts to institutions of higher learning under its Corporate Alumnus Program.

Of the competitive fellowships, 18 are in the physical sciences, engineering, and industrial management under the Coffin-Swope-Rice Funds. Under the Owen D. Young Fund, six fellowships were granted in the arts and sciences, graduate law, and business. Ten GE Fellowships were granted in the physical sciences and engineering.

The Charles A. Coffin Fellowships were established in 1923 and since that time 230 such awards have been made. In 1945, the Gerard Swope Fellowships were established and since then 77 have been awarded. The Edwin W. Rice, Jr., and Owen D. Young Fellowships were awarded for the first time in 1955-56 and since then 18 of each have been granted. The GE Fellowships also were awarded first in 1955-56 and since then 30 have been granted by the Fund.

Mr. Coffin was the first president, Mr. Rice was the second president, Mr. Swope was the third president, and Mr. Young served as board chairman of GE from 1922 to 1940 and during the World War II years.

Winners of competitive fellowships were selected by a committee including representatives from the AIEE, National Academy of Sciences, American Chemical Society, American Physical Society, American Society for Engineering Education, the American Society of Mechanical Engineers, and other educational representatives.

Electrical Engineering Education

An Electrical Engineer in Industry

E. B. ROBERTSON (M '24, F '45), president, Elgin B. Robertson, Inc.; president, Plastics Manufacturing Co.; past president of AIEE.

"I would like to urge upon all electrical engineers, and especially students and young engineers, active participation in the AIEE. It will be worth your while, and it is part of your obligation to your profession. You need the AIEE, for it will afford you: wider sources of information, more varied personal associations, broader stimulation to achievement, and less formal contact with your seniors than you have in your daily job.

"It will provide you with a means of expression and an outlet for your organizing and executive abilities. Friendships will be formed which will be of lasting satisfaction to you. As you become older, your society will be a means of service to your fellow engineer, and this will warm your heart as nothing else will."

Mr. Robertson received his E.E. degree from the University of Texas in 1915. He was also awarded the D. Eng. degree from Southern Methodist University in 1953. Following his graduation in 1915, he became affiliated with the Westinghouse Electric & Manufacturing Co. (now Westinghouse Electric Corporation) at East Pittsburgh, Pa., first as a graduate student and later as a designer of large power transformers. In 1920, he joined the Railway & Industrial Engineering organization as chief electrical engineer at Greensburg, Pa. He was later made division manager with offices in Chicago, Ill.

In 1928, Mr. Robertson moved to Dallas, Tex., and established Elgin B. Robertson, Inc. He has been president since its incorporation. When Plastics Manufacturing Co. was organized in 1939, he was made president of that company.

In 1942, he joined the War Production Board as production engineer, later becoming regional utility engineer and regional manager of production.

Mr. Robertson has been active in the Texas Society of Professional Engineers, serving as a member of the board of directors and as president of the society.

Mr. Robertson, who was president of the Institute 1953-54, has served on numerous AIEE Committees including Membership, General Applications Division, Professional Division Advisory, Lamme Medal, Edison Medal, John Fritz Medal, and Adminstration Department. He has been chairman of the Registration of Engineers Committee and Planning and Co-ordination Committee, and has served on the Board of Directors 1947-51, October 1951-56.

Electrical Engineering Education

AEC Graduate Fellowship Program Broadened

In order to meet the increasing demand for highly-trained scientists and engineers in nuclear fields, the Atomic Energy Commission (AEC) has broadened one of its special fellowship programs to include study through the doctorate level.

Fellowships, to be known as the "AEC Special Fellowships in Nuclear Science and Engineering," have been established to provide a total of 150 fellowship grants on a one-year basis to first-, second-, and third-year graduate students.

The fellowships carry basic stipends of $1,600, $1,800, and $2,000 respectively, with additional allowances for dependents, tuition, and travel. The original program, at that time called "AEC Special Fellowships in Nuclear Energy Technology," was announced on October 30, 1956, and supported one year of study at the first-year graduate level.

The revised program is the result of the increased demand for scientists and engineers with more advanced training in nuclear technology and provides the opportunity for a large number of graduate students to pursue, at certain universities, studies in the nuclear aspects of conventional scientific and engineering disciplines in addition to basic work in the reactor technology field.

The Oak Ridge Institute of Nuclear Studies (ORINS), which operates under contract with the Oak Ridge Operations Office of the AEC, will continue to administer the broadened program. ORINS also administers for the AEC the special fellowships in radiological physics, the special fellowships in industrial hygiene and the ORINS graduate fellowship program.

A fellowship board composed of representatives of industry, educational institutions, and the AEC will make the final selection of the 1958-59 candidates about March 15, 1958.

Applications are open to graduates in chemistry, engineering, mathematics, and physics. Application forms may be obtained from the University Relations Division, Oak Ridge Institute of Nuclear Studies, P. O. Box 117, Oak Ridge, Tenn.

AIEE St. Louis Section Meets with Student Branches

The annual joint meeting of the St. Louis Section of AIEE with the student branches of the Missouri School of Mines, St. Louis University, Washington University, and the University of Missouri was held October 18, 1957, in Columbia, Mo.

Following a dinner, Roger Pape, chairman of the University of Missouri Branch, delivered the welcome. Ed Sheen, vice-chairman of the University of Missouri Branch, introduced Dr. R. J. W. Koopman, chairman of the St. Louis Section, and Roy Gore, chairman of the Kansas City Section, each of whom spoke briefly.

Jim Burkhart, chairman of student activities of the St. Louis Section, introduced Harold Gove of the Union Electric Company, the speaker for the evening. Mr. Gove's speech, "Atomic Energy Today and Tomorrow," accompanied by a movie and slides, was very interesting and enjoyed by all those present.

Some 21 members and 80 student members attended the meeting.

MISTIC Aids Research at Michigan State University

MISTIC, a giant electronic "brain" standing 10 feet tall, started to flex its muscles for research at Michigan State University (MSU) in October.

An estimated 400 engineers, on hand for the second annual MSU Engineering Alumni Reunion, were the first to see a public demonstration of the new digital computer built by university staff members.

The computer is an unbelievably complex maze of wires, circuits, tubes, and transistors—dozens of television chassis stacked one atop another might give some idea of its appearance. A team of MSU staff members painstakingly put it together in about a year.

As an electronic brain, the computer can multiply 40-digit numbers in millionths of a second, and can calculate in hours solutions to complicated problems that would take a man a lifetime to solve. It can wade through mountains of facts and come up with answers.

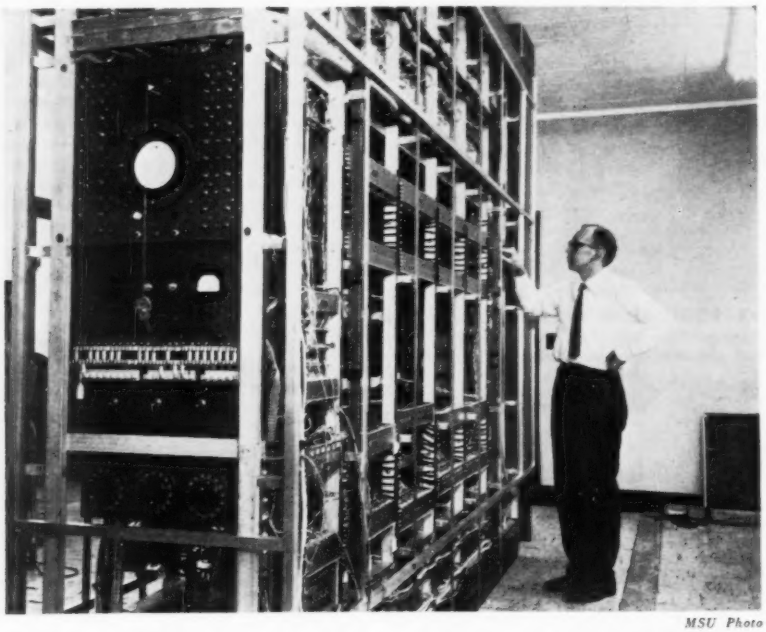
The speed with which MISTIC (short for Michigan State Integral Computer) can solve problems makes it possibly the most valuable research tool ever built at the university. It will be used to answer problems originating in areas such as physics, mathematics, chemistry, engineering, agricultural economics, and many others.

"The computer is as accurate as the information we give it," asserted Dr. L. W. Von Tersch, director of the MSU computer laboratory, who supervised MISTIC's construction. "The machine must be given the information it needs to work with and told what to do with the facts. If the person feeding in the problem makes an error, the answer will be in error."

"The importance of the computer to research," he explained, "is that now we can tackle almost any project we want to. It means we won't have to give up a line of research just because it involves an immense amount of mathematical computation."

At MSU, for example, members of the agricultural economics department already are prepared to use MISTIC in efficiency studies for farm and food processing plant production. Better crops and better processed foods could be the result. Statistical problems are to be studied too.

People in the College of Engineering's applied mechanics department intend to make a theoretical analysis of metal stresses. University psychologists look for-



MSU Photo

MILES OF WIRE, nearly 3,000 tubes and transistors, and countless circuits were painstakingly assembled to create MISTIC, the big electronic computer at Michigan State University (MSU). Checking over the assembly of the electronic "brain" is Dr. G. P. Weeg, assistant professor of mathematics, who is teaching students to use the valuable research tool. It was constructed in the MSU electrical engineering department.

ward to wide use of the computer in analyzing extensive collections of experimental data. A priority list of projects will be necessary.

"The university will not lack for trained hands to operate the computer," Dr. Von Tersch added. "We have more than 100 students in a course in computer coding who will be able to operate the machine by the end of the term." Computer coding is being taught by Dr. G. P. Weeg, assistant professor of mathematics.

Contribution Made to Colorado School of Mines

Dr. J. W. Vanderwilt, president of the mineral engineering college of the Colorado School of Mines, Golden, Colo., announced recently that the school had received a second contribution of $1,000 from the Morse Brothers Machinery Company, Denver, Colo. The check was sent to the school by Max Grimes, the president of the Denver firm.

This gift is the second payment on a $5,000 pledge made by the firm last year, and similar installments will be paid until the pledge is fulfilled. This portion of the pledge was restricted to the capital improvement program being directed by the Colorado School of Mines Foundation, Inc. The Foundation is designed to accept private grants and aid for Mines, a state-supported institution.

AIEE-IRE Students Hold Inter-University Convention

Electrical engineering students and faculty representatives from four Michigan universities met at the University of Detroit on October 25, 1957, for the AIEE-Institute of Radio Engineers (IRE) Inter-University Student Convention.

The 225 students represented the University of Detroit, University of Michigan, Michigan State University, and Wayne State University.

The convention gave the students an opportunity to tour some of Detroit's major industrial sites including the General Motors Technical Center, Bendix Aviation Research Laboratories, the Chrysler Corporation Engine Plant, the Michigan Bell Microwave Installation, the Ford Research Laboratory, and the Detroit Edison River Rouge Power Plant.

After registration in the morning, students spent the balance of the day on the company guided tours. In the evening, the conventioneers had an opportunity to compare notes on what they had seen in the afternoon at a banquet held in the University of Detroit Student Union Ballroom. Students were guests of the industries they toured at both the dinner and luncheon earlier in the day.

Main speaker at the banquet was Rev. J. A. Petz, S. J., of the University of Detroit Law School. His subject was "The Relationship between Law and Engineering."

Father Petz outlined the ways in which engineering is subject to the law and how engineering could aid legal processes in the future.

The purposes of the convention were outlined by University of Detroit AIEE chairman, James Crimmins. He stated the objectives of the event as follows:

(1) To promote interuniversity student relationships in such a way as to form professional bonds.

(2) To establish a vehicle for associations between the engineering undergraduate and industry.

(3) To extend the means for social development of the embryonic engineer through organizational activity.

The success of this year's convention has encouraged University of Detroit engineering students to make it an annual event.

Harvard-Guggenheim Center for Aviation Health and Safety

There are 13 military and civilian doctors and engineers registered in the first postgraduate study program in the Harvard–Guggenheim Center for Aviation Health and Safety now under way at Harvard University's School of Public Health in Boston, Mass.

Among those enrolled are members of the U. S. Air Force, the U. S. Army, Australia's Department of Civil Aviation, the Royal Canadian Air Force, the Swedish Air Force, a Swedish aircraft manufacturing firm, and an American commercial airline company.

The Center—the fifth and newest of aviation research centers established in the United States by The Daniel and Florence Guggenheim Foundation—is under the technical direction of Dr. R. A. McFarland, associate professor of industrial hygiene at Harvard. It is the first Center set up by the Foundation dealing directly with aviation health and safety. Support of the program is through a $250,000 grant from the Foundation, extending over a five-year period.

Dr. T. O. Nevison, Jr., of Cambridge, Mass., has been awarded the first Daniel and Florence Guggenheim Fellowship, Dr. McFarland has announced. The Fellowship, in the amount of $5,000, is awarded annually for graduate study at the Center.

At the Harvard–Guggenheim Center, attention is focused on: the unification of basic research involving studies of human problems in the era of jet aircraft; advanced training for physicians, biological scientists, and aeronautical engineers in problems involving aviation health and safety; and establishing a clearing house for technical information on aviation health and safety.

Among the specific problems to be studied at the Harvard–Guggenheim Center will be responses of the human body to extreme speeds, altitudes, temperatures, and to toxic agents in flight and on the ground. Basic research will be directed to the prevention and control of the increasing dangers of the air age.

Electrical Engineering Education

Kodak Program of Aid to Higher Education

Eastman Kodak Company has announced the awarding of 58 direct grants and 39 fellowships, having a combined value of over $400,000, to colleges and universities in the United States.

The company also announced a contribution of $175,000 in special grants to colleges and universities in areas where

Photo by Dee Haun

THE REV. J. A. PETZ, S.J., professor of law at the University of Detroit, addresses a joint meeting of AIEE student chapters from the University of Detroit, the University of Michigan, Michigan State University, and Wayne State University. He spoke on "Engineers and the Law" in the Student Union Ballroom on the University of Detroit campus.

Electrical Engineering Education

Kodak has special manufacturing interests, and an award of $32,000 to associated college groups and other organizations established for educational purposes.

These various awards are part of the continuing Kodak program of financial aid to higher education.

The direct grants, valued at $286,000, will go to 58 privately supported colleges and universities on the basis of graduates of those institutions who joined the company five years ago and are presently employed.

Some 20 fellowships will be awarded to persons studying for the Ph.D. degree in chemistry, six for Ph.D. degree study in physics, and 13 for engineering students working for the master of science degree. These fellowships, for the 1958-59 academic year, are valued at $120,000.

The company's total expenditure for educational assistance this year amounts to approximately $600,000, not including the 1958-59 fellowships which will be paid next year.

Marquette University To Open Computing Center

Marquette University's application for a *650* digital computer has been approved by the International Business Machines Corporation, and the $200,000 machine will be installed on a rental basis next August. With installation of the *650*, Marquette will open its computing center in the college of engineering. Arthur Moeller, assistant professor of electrical engineering, is chairman of the computing center committee.

Special Fellowships in Radiological Physics

Hundreds of young American scientists are being offered the opportunity to get into an even younger field of science—that of radiological physics, or health physics. Special fellowships in the field are provided by the U. S. Atomic Energy Commission (AEC), and are described in a new brochure issued by the Oak Ridge Institute of Nuclear Studies (ORINS), which administers the fellowship program for the AEC.

Radiological physics is a profession hardly older than the atomic age. It is concerned with the study, evaluation, and control of radiation hazards, and the mushrooming use of radioactive materials in all phases of research and technology has produced a corresponding demand for trained health physicists.

To meet this demand, the AEC several years ago established this special fellowship program, open to qualified college graduates seeking careers in this new field of science.

ORINS, a nonprofit educational corporation of 36 southern universities, awards fellowships for study at 4 different universities and 3 AEC installations in widely scattered geographical locations. Each program provides nine months of regular university graduate work, together with three months of additional study and field training at a co-operating AEC installation. The programs are carried out at Vanderbilt University and Oak Ridge National Laboratory; the University of Rochester and Brookhaven National Laboratory; and the Universities of Kansas and Washington and the Hanford Atomic Products Operation.

Details of fellowship requirements and stipends may be obtained by requesting a copy of the brochure, "Career Opportunities in Radiological Physics," from the Radiological Physics Fellowship Office, Oak Ridge Institute of Nuclear Studies, Oak Ridge, Tenn.

Engineering and Scientific Education in the United Kingdom

The Newsletter issued jointly by the Engineering Manpower Commission (EMC) of Engineers Joint Council and the Scientific Manpower Commission (SMC), presents the following report on engineering and scientific education in the United Kingdom.

For more than two years, the EMC and SMC have been placing much more emphasis upon the quality and training of technologists than upon an increase in numbers. Although the British are still preoccupied with shortages, their attention is also shifting to educational problems.

On May 13, a special committee appointed by the Minister of Education to investigate the supply and training of teachers in technical colleges reported that the current staffing situation is far from satisfactory. It points out that, between 1952 and 1955, the number of full-time students in the colleges rose from 41,000 to 53,000, and the enrollment of part-time students went from 305,000 to 370,000. To handle the increase, the colleges recruited annually 770 full-time teachers, but recently formulated plans for expansion will create a demand for 1,430 new full-time teachers a year to fill out staff requirements during the same period.

In "Technology," its "Monthly Review of Training and Education for Industry," the London *Times* summarizes the committee report and publishes several other articles that have a familiar ring and could apply just as well to the technological manpower situation in this country. The need for civil engineers is stressed in a full-page article. Another deals with the importance of keeping abreast of the fundamentals of science, especially on the part of specialists, whose specialty will suffer from the law of diminishing returns if it is not kept in harmony with rapid advances in the basic sciences. Reference is made to Circular *323* on liberal education in technical colleges, wherein the Minister of Education emphasizes the need for students to acquire a broad look and a sense of spiritual and human values, as well as technical accomplishment.

Even the advertisements are reminiscent of those that have appeared in American newspapers—industry in search of scientists and engineers. As if to give point to the need for the arts and humanities in technological education, the *Times'* monthly review devotes 2 of its 40 pages to music and the drama. Whether this amount of space is meant to suggest the proper ratio of the humanistic element in technological education, we do not know.

Dr. Sirkis Named Head of Rutgers Microwave Laboratory

The appointment of Dr. M. D. Sirkis, former research assistant professor at the University of Illinois, to head up a new microwave electronics laboratory at Rutgers University has been announced by Dr. L. W. Jones, president of the State University.

Dean E. C. Easton of the Rutgers College of Engineering said the new laboratory, one of very few in the country, will provide faculty members an opportunity to engage in research in the rapidly growing field of microwave technology. Courses of study in microwave electronics on the graduate level will be offered under Dr. Sirkis' direction.

The dean said Rutgers has established the unit in response to a growing need among New Jersey industries for persons with advanced training in microwave tube technology. He pointed out that a number of New Jersey industries are putting equipment and manpower into microwave development and that its use is spreading rapidly to new fields.

Research in microwave electronics, which deals with the study of the interaction of electromagnetic radiation and electronic currents, may provide a key to future advances in military equipment, communications, chemistry, and controlled nuclear fusion.

NCR Presents Computer to Antioch College

The National Cash Register Co. (NCR) is presenting an electronic digital computer to Antioch College. President S. B. Gould told the college's board of trustees at their fall business session on October 18.

Among the Antioch trustees present at the meeting was R. G. Chollar, vice-president in charge of research for NCR. Mr. Chollar briefly explained the computer's specifications and formally presented it to the board of trustees on behalf of S. C. Allyn, chairman of the NCR board.

The computer, complete with an auxiliary tape memory unit and input-output

equipment, ultimately will be installed in the remodelled Main Building of the college.

Chief use of the computer on the campus will be to enhance the teaching and research activities of the college, President Gould told the trustees.

Work already in preparation for the computer includes research on the diffusion of gases, being conducted by Dr. A. B. Stewart, some of the research under the direction of Dr. J. I. Lacey at the Fels Research Institute, problems for the Wright Field Anthropometric Project on the campus, problems for the Vernay Laboratories, and educational research of the college's own testing office.

Plans are also under way for its use in conjunction with academic course work in such areas as engineering of machine design and accounting systems and machines.

The college hopes also to provide a service to research projects, industry, and other educational institutions in the area.

Graduate Enrollment Up 25% at Lehigh University

More than a 25% enrollment increase in the Graduate School of Lehigh University has been reported by J. H. Wagner, registrar. He announced an enrollment of 703 graduate students this semester as compared with 560 registered in the Fall of 1956.

The Graduate School at Lehigh, under the direction of Dean F. E. Myers, offers work leading to the master's degree in 25 fields, and to the doctorate in bacteriology, chemical engineering, chemistry, civil engineering, electrical engineering, English, geology, history, mathematics, mechanical engineering, metallurgical engineering, and physics.

The greatest increase in graduate enrollment is in the mechanical engineering department with 40 more students than a year ago. The advanced offerings of the department of education have attracted 25 new students in the past year, bringing the total registration in that division to 223.

An increase of 20 students in business administration was noted by Mr. Wagner who reported that 71 men are working toward their master of business administration degree.

The increase in electrical engineering and physics consisted of 15 students in each department. An additional 10 each have enrolled in history, industrial engineering, and metallurgy.

Scholarship Awards Made by Dow Corning Corporation

Seven scholarships for a full year's study in electrical engineering have been awarded by Dow Corning Corporation for the current year.

The scholarship program, now in its seventh year, pays all tuition costs in addition to a sum for expenses. Scholarship recipients also receive an inscribed volume of "Insulation of Electrical Machinery" by Willis Jackson.

Recipients of the current scholarships are: Charles Schwarz, Case Institute of Technology; C. M. Klingman, Iowa State College; A. T. Lewis, Massachusetts Institute of Technology; R. E. LeCronier, Michigan State University; Thomas Fessenden, Michigan College of Mines and Technology; Richard Whipp, Purdue University; and J. W. Martin, Texas A & M College.

Administered by the Electrical Section of the Product Engineering Laboratories at Dow Corning, the scholarship program is intended to stimulate interest in and encourage the study of the dielectric properties of electrical insulating materials.

Engineering Awards Made by Lincoln Foundation

Engineering undergraduates in 26 engineering schools and universities received recognition and awards this year in the annual competition sponsored by The James F. Lincoln Arc Welding Foundation of Cleveland, Ohio, for student designs of welded machines and structures. A total of 46 awards amounting to $5,000 were given to engineering undergraduates. Duplicate awards in scholarship funds were presented to schools honoring the students whose designs received the main awards. Awards were made for papers submitted to The Lincoln Foundation presenting designs of machines and structures improved through the use of welded design.

The First Grand Award of $1,250 went to a husband and wife engineering team, Charles and Ann Hutchins who, as undergraduates at the University of Michigan, collaborated to submit an entry on the design of various parts used in a welded two-stage press. Ann was enrolled in the College of Architecture and Design; Charles was in the mechanical engineering department. Their departments were each given $500 in scholarship funds honoring their achievement. In the 10-year history of the Lincoln Foundation competition, this is the first year a woman has received recognition among the generally predominant male engineering undergraduates.

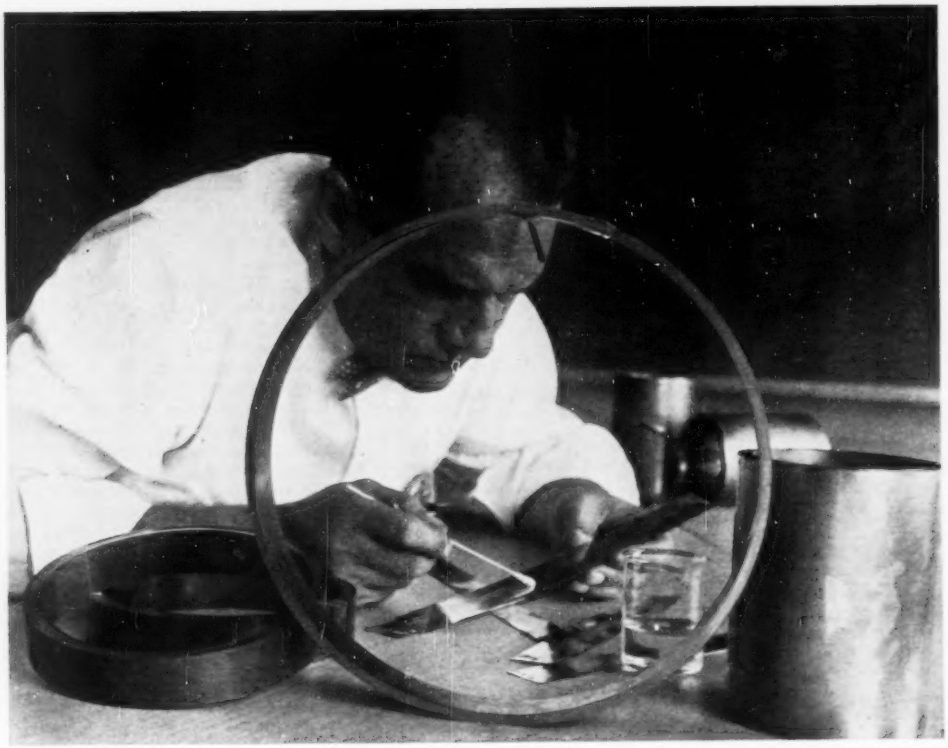
Electrical Engineering Education

Lady Engineers

Clemson News Bureau Photo

AMONG FIRST TERM GRADUATES of the Bell System Communications Engineering School at Clemson College are the first two women engineers in Southern Bell history. Reporting on class findings while designing a composite filter are *(left to right)* Mrs. Bess M. Kirkland (AM '52) of Birmingham, Ala., and Miss Wanda Carter of Nashville, Tenn. Both are assistant transmission and protection engineers. "Women are naturals," says Mrs. Kirkland, "for careers in engineering. They have more imagination than men, greater attention to detail and better budgeting sense." The lady engineers point to a growing trend toward engineering aids—employees beyond the clerical level. There is a preference being shown, they report, for women in these intermediate positions.

OF CURRENT INTEREST



SCIENTIST framed by coils of magnetic steel is R. B. Aspden, metallurgist at Westinghouse Laboratories. He is applying a chemical etch to strips of Cubex that enables scientists to study the metal's "cube orientation." Easily magnetized in four directions instead of two, the new magnetic steel has been produced on a pilot-plant scale here, and produced and applied by Vacuumschmelze in Germany.

Scientists Develop "Four-Way" Magnetic Steel

CLIMAXING a 25-year search by the electrical industry, scientists have recently announced a new kind of magnetic steel which allows magnetism to turn around corners, and which promises to improve the performance and simplify the construction of electric apparatus.

Announcement of the new material, called "Cubex" steel, was made by Dr. Clarence Zener, director of Westinghouse Research Laboratories, Pittsburgh, Pa., during a press conference. He described it as "a major scientific breakthrough for the electrical industry."

The magnetic material is a new kind of steel technically known as "doubly oriented silicon-iron," or "cube-oriented silicon-iron." It is expected to be used in the magnetic cores of electric devices such as transformers, motors, and other electric equipment.

Scientific Co-operation

The unique metallurgical processes involved in preparing the new silicon-iron were originated by scientists at the Vacuumschmelze A. G. of Hanau, Germany—a Division of the Siemens-Halske Company. Westinghouse research scientists have extended this work and have provided basic information necessary to the progress of this material to its present state of development.

In preparing the new material, the Westinghouse scientists revealed they had discovered a new mechanism for crystal growth in metals. As a result, the new silicon-iron has a unique crystal arrangement, contrary to that normally encountered in the metal, and difficult to bring into being.

The crucial characteristic imparted to the new steel by its unusual crystal orientation is an ability to be magnetized easily in four directions. This permits magnetism to "turn the corners" readily in the magnetic core of a piece of electric equipment.

The conventional steel now used in magnetic cores is known as "singly oriented." It can easily be magnetized in two directions only: that is, back and forth along the direction in which the steel is rolled during manufacture. For this reason, to provide the best magnetic path all around the rectangular core of a large transformer, the core is built up of straight strips of metal laid at right angles into a rectangular shape.

Simplifies Core Construction

In the case of the new material, however, L-, E-, U-shaped, or even rectangular punchings, could be stamped from a sheet of steel in one operation. This, in many cases, would simplify construction of the core, in addition to giving an improved magnetic path.

"A core of magnetic steel is the unseen and rather undramatic 'heart' of almost every piece of electric apparatus," Dr. Zener said, "and the average person, perhaps, is unaware of its vital role in the generation, distribution, and use of electric power.

"Yet, the kind of material from which a magnetic core is made has a direct effect upon every consumer of electricity. Over the years, improvements in magnetic steels consistently have raised the efficiency of transformers and other electric apparatus. This has lowered losses, conserved power, and reduced the total electric bill of the nation by millions of dollars annually."

It was also pointed out that hot-rolled unoriented silicon-iron—the first true magnetic steel—was introduced into the electric industry at the turn of the century. Then came singly oriented silicon-iron, called Hipersil, which was developed and pioneered by Westinghouse and the American Rolling Mill Company in the

1930s. It represented a major advancement, and Hipersil-type iron still remains the best core material in large-scale use today.

Since that time, a continous program of research has been conducted on oriented silicon steel. The goal has been a high-quality, inexpensive cube-oriented material capable of large-scale manufacture. Although considerable work still must be done in "scaling up" this new Cubex steel and finding the best ways of using it, Westinghouse now believes that the goal sought has been reached.

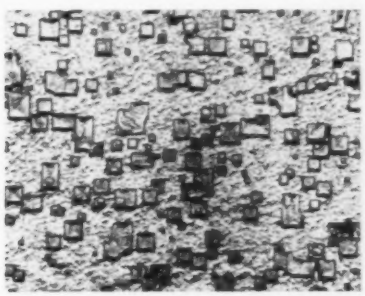
Three scientific laboratories were involved in the research and development which produced the new magnetic steel: the Vacuumschmelze laboratory in Germany, the Westinghouse Research Laboratories, and the Westinghouse materials engineering magnetics laboratory. The work at the Westinghouse Research Laboratories was under the direction of Dr. G. W. Wiener.

Differences

Cubex steel, Dr. Wiener explained, has about the same chemical composition as the standard magnetic variety—about 3% silicon to 97% iron. The real difference between the two comes from the way the steel is handled during its processing from rough sheet into the final product.

The process responsible for producing cube-oriented silicon-iron has been shown to be operative in sheets thick enough to make it feasible for use in large transformers and motors. In thin strip, which is much easier to prepare, it has been made on a pilot-plant scale at the Westinghouse metals development plant at Blairsville, Pa. Such strip, about five thousandths of an inch thick, is of the dimensions used in airborne transformers, relay cores, and similar electronic and electric equipment.

"It should be emphasized," said Dr. Wiener, "that, thick or thin, Cubex steel has not yet 'graduated' from the laboratory stage of development. We cannot yet predict just how soon it will find general use in the electric industry. Specialized uses requiring only thin sheet will, no doubt, be the first commercial applications to be encountered, possibly within the next few months."



DRAMATICALLY illustrating its "cube orientation" as viewed through a microscope, the easily magnetized new silicon steel called Cubex is expected to bring smaller, lighter, and more efficient electric equipment, by permitting magnetism to turn the corners in the magnetic cores of electric apparatus.

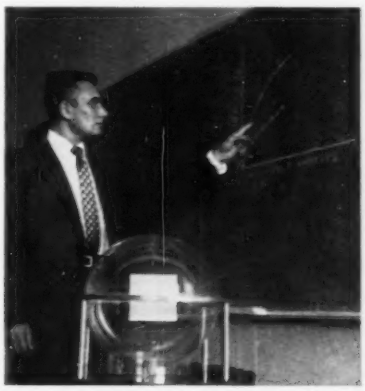
Crystal Structure Reorganized

The new cube-oriented silicon-iron was obtained by actually reorganizing the crystal arrangement normally found in the metal. Nature has arranged atoms of iron in such a manner that they form crystals in the shape of tiny cubes. Magnetically, it turns out that the direction along any edge of the cube represents an easy path for magnetization: directions across any face of the cube, or diagonally through it, represent difficult paths. Therefore, to have a good magnetic core material, these tiny cubic crystals must be lined up properly, or oriented, in the metal.

The crystal arrangement in a sheet of the new cube-oriented magnetic steel might be compared to the arrangement of a tray of ice cubes. Each cube rests flat on one side and squarely faces the ends and sides of the tray. Therefore, the edges of each cube are exactly aligned with each other and are always parallel to the ends (width) and sides (length) of the tray.

In just this way the crystals in Cubex steel are aligned. Since the cube edges represent easy directions of magnetization, good magnetic paths exist along both the width and the length of the sheet. Contrary to this, crystals in ordinary singly oriented silicon-iron are so arranged that only the lengthwise path exists. It is as though the ice cubes all faced one end of the tray as before, but instead of resting on one face, by some sort of magic, they stand on edge. In such case, the only cube edges parallel to a surface are those aligned with its length. In a sheet of this steel, length represents the only easy path of magnetization.

Perhaps the greatest problem encountered in making the new material was, so to speak, that of getting the iron crystals to tip over and lie flat on their faces. For many years, authorities in magnetics have pointed out the need for an inexpensive cube-oriented magnetic material. "It is the next logical step in the continuing search for a better magnetic core material—which search has never



MAGNETIC SUPERIORITY of Cubex is pointed out by Dr. G. W. Wiener, advisory metallurgist at the Westinghouse Research Laboratories, in curves plotted for oriented and non-oriented steels. Model in foreground illustrates crystal arrangement which gives Cubex its unusual magnetic properties.

Future Meetings of Other Societies

ISA, 2nd Yankee Instrument Fair and Symposium, Jan 14-15, Hotel Bradford, Boston, Mass. ISA-Boston Section, Inc., Box 282, Boston 1, Mass.

Institute of Human Communications Seminar

Communication in Successful Product Planning, Jan 20-22, Harvard Club, 27 W 44th St, New York, N. Y. Wm. Exton, Jr., 101 W 57th St, Rm 1112, New York, N. Y.

Enlarging Managerial Capacity, Feb 24-28, Harvard Club, same

4th UN Scientific Committee Session on Effects of Atomic Radiation, beginning Jan 27 and continuing as necessary, United Nations, New York, N. Y. Prof. Zenon Bacq, Belgium; or Dr. E. A. Watkinson, Canada

ASHACE, Annual Meeting, Jan 27-29, Pittsburgh, Pa.

Plant Maintenance and Engineering, 1957 Show, Jan 27-30, International Amphitheatre, Chicago, Ill., Clapp & Poliak, Inc., 341 Madison Ave., New York, N.Y.

Engineering and Management, 1958 Course, Jan 27-Feb 6, College of Engineering, Graduate School of Business Administration, University of California, Los Angeles Campus, Los Angeles, Calif., E. P. Coleman, Co-ordinator, E & M Course, C of E, University of California, Los Angeles, Calif.

SPE, 14th ANTEC "Progress through Plastics Engineering," Jan 28-31, Sheraton-Cadillac Hotel, Detroit, Mich., C. H. Whitlock, C. H. Whitlock Associates, 21655 Coolidge Hwy., Oak Park, Mich.

ASEE, 1958 College-Industry Conference, Jan 30-31, University of Michigan, College of Engineering, Ann Arbor, Mich., Relations with Industry Division, ASEE, 255 West Engineering Bldg., Ann Arbor, Mich.

SPI, Reinforced Plastics Division, 13th Annual Technical and Management Conference, Feb 4-6, Edgewater Beach Hotel, Chicago, Ill. G. L. Smead, Manager Reinforcement Sales, L-O-F Glass Fiber Co., Toledo, Ohio

ASQC, 2nd Annual Conference of Administrative Applications Division, Feb 7-8, Carter Hotel, Cleveland, Ohio. W. C. Lynam, B. F. Goodrich Chemical Co., 3135 Euclid Ave., Cleveland 15, Ohio

ASTM, National Meeting, Feb 10-14, Hotel Statler, St. Louis, Mo. American Society for Testing Materials, 1916 Race St, Philadelphia 3, Pa.

AIME, Annual Meeting, Feb 16-20, Hotels Statler and Sheraton-McAlpin, New York, N. Y. H. N. Appleton, AIME, 29 W 39th St, New York 18, N. Y.

National Wiring Conference, 14th Annual Meeting, Feb 20-21, Statler Hotel, Detroit, Mich. Frances Armin, National Wiring Bureau, 155 E 44th St, New York 17, N. Y.

ASCE, Convention, Feb 24-28, Chicago, Ill. D. Reynolds, ASCE, 33 W 39th St, New York, N. Y.

ASME, Gas Turbine Power Division Conference and Exhibit, Mar 2-6, Shoreham Hotel, Washington, D. C. L. S. Dennegar, ASME, 29 W 39th St, New York, N. Y.

Rocky Mountain Petroleum Sections, 4th Annual Joint AIME Meeting, Mar 3-4 Cosmopolitan Hotel, Denver, Colo. H. N. Appleton, AIME, 29 W 39th St, New York, N. Y.

SPI, 16th Annual Canadian Section Meeting, Mar 6-7, Royal Connaught Hotel, Hamilton, Ont., Canada. L. P. Williams, SPI, 250 Park Ave, New York, N. Y.

1st National Lighting Exposition, Mar 9-12, New York Coliseum, New York, N. Y. Harold Meyer, c/o C. J. Wyle, Wyle Associates, Inc., 250 W. 57th St., New York, N. Y.

The Institution of Electrical Engineers, International Convention on Microwave Valves, May 19-23, Institution Building, Savoy Place, London W. C. 2, England, W. K. Brasher, IEE, same.

failed to produce smaller, simpler, more efficient, and less expensive electric equipment. Ultimately, Cubex steel is expected to meet these demands.

First Success

Dr. Wiener disclosed that the original technical report of success with cube-oriented silicon steel was made by Vacuumschmelze scientists in 1956. Dr. Klaus Detert of the Vacuumschmelze laboratory briefly described these earlier experiments and findings.

At the laboratory in Hanau, it was decided to emphasize studies in silicon-iron simply to get more scientific information on how it responds to treatment. Nobody expected the discovery of a new procedure that would result in a new kind of orientation.

"You will understand how thrilled we were, Dr. Detert stated, "when our trials resulted in cube-orientation. This was the beginning of the discovery of how an unknown mechanism of crystal growth provides this unique orientation in silicon-iron. We are happy to be part of this first public announcement of such a major research development."

The experimental work done thus far has shown that cube-oriented iron alloys of the kind described can be made. The work required now will be to obtain a deeper understanding of the factors involved in the preparation of the material so that its widespread commercial use will be practiced in the future.

Mass Production of Low-Power Research Reactors

A PORTABLE educational and low-power research reactor was exhibited in operation for the first time in the State of New York. The commercial unit was manufactured by Aerojet-General Nucleonics, (AGN), San Ramon, Calif., subsidiary of Aerojet-General Corp. and the General Tire and Rubber Co.

Of significance was the fact that this particular reactor was to be installed at the U.S. Naval Hospital, Bethesda, Md., upon completion of the exhibit which was part of the "AtomFair" at the Atomic Industrial Forum held recently at the New York Coliseum in New York, N.Y.

It was placed into operation for medical purposes, and is believed to be the first reactor to be utilized exclusively for medical purposes. The announcement and execution of these plans were the work of Dr. A. T. Biehl, technical director, and Robert Mainhardt, general manager of the division which is located about 15 miles east of Oakland, Calif.

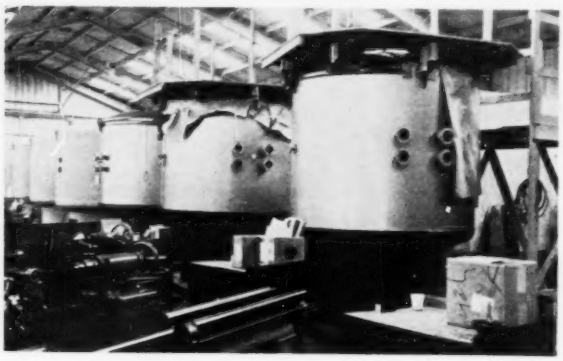
Exhibition of this operating "mass produced" reactor in the heart of the world's largest city is a dramatic illustration of the rapid advancements being made in reactor safety and technology. In addition to being judged safe enough by the Atomic Energy Commission (AEC) for installation and operation in existing buildings, this is stated to be the only reactor in the world to be in mass production at present.

The unit on exhibition was the tenth production model to be manufactured on AGN's production line and is basically the same as those AGN *201*'s which are located at the Argonne National Laboratory, Akron University, Catholic University of America, Colorado State University, Utah University, Oklahoma State University, Agricultural and Mechanical College of Texas, and the U. S. Naval Postgraduate School, Monterey, Calif. The unit consists of a completely and safely enclosed "critical" uranium core and a relatively simple control console. Fission of the U-235 atoms can be completely controlled from the control console with the simple push of a button. Hundreds of visitors to the "AtomFair" were afforded their first opportunity to operate a reactor. Typical reactor start up and shut down, effects of neutron absorbers on reactor operation, and production of radio-isotopes were demonstrated.

The AEC has authorized the construction of 21 reactors of this type and it has now become almost a routine matter to license the reactor for operation in any environment. For example, the decision to display this particular reactor at the "Atom Fair" could not be determined until the early part of October, yet in a matter of 20 days, complete arrangements were made. This efficiency in the operation of the licensing branch of the Division of Civilian Application of the AEC has manifested itself in the ready accession of nuclear facilities by American industry, educational institutions, and research groups. In addition, the AEC has adapted itself readily to the licensing problems of "mass produced" reactors.

The exhibited reactor was completely built and thoroughly tested at AGN's San Ramon facility. The entire reactor system (less fissionable core) was shipped to New York City, intact, by regular truck line; the fissionable core was flown to New York aboard a commercial airliner. After setting the reactor at location in the Coliseum only a few hours were required to place it in operation. It was necessary only to set the fissionable core into place, add 1,000 gallons of water for shielding, and place the reactor into operation by manipulating the control rods. Although capable of operating at higher powers, the AGN *201* reactor will be operated at the low safe "teaching power" of 100 milliwatts.

SITTING among all the essential components that make a complete AGN 201 nuclear reactor are Robert Mainhardt (left), general manager, and Dr. A. T. Biehl, technical director for Aerojet-General Nucleonics. White discs in foreground are replicas of the fuel discs.



PRODUCTION line where nuclear reactors are being mass produced at the Aerojet-General Nucleonics plant shows units in various stages of assembly.

Atom-Fueled *N.S. Savannah* Merchant Ship To Sail in 1960

The world's first nuclear powered merchant ship will be built at the shipyards of the New York Shipbuilding Corporation, Camden, N. J.

It has already been named the *N.S.* (nuclear ship) *Savannah* by Pres. Eisenhower, C. G. Morse, Maritime Administrator, and L. L. Strauss, AEC Chairman, whose agencies are building the ship as a joint experiment under special legislation and appropriations secured for the purpose, made the announcement of the award of contract.

The nuclear engine for the merchant vessel will be furnished by the Babcock & Wilcox Co., New York, N. Y.

After several months of negotiations, the Government decided on the firm and

construction will begin shortly. The atomic merchant ship's building schedule calls for the keel to be laid in 1958. The launching is scheduled to take place in 1959. It is expected that the ship will be completely ready for its scheduled 1960 delivery.

The design for the *N.S. Savannah* was completed in September 1957 by George G. Sharp, Inc. It calls for a vessel which is 587 feet long and 78 feet in-beam, with a full-load replacement of 21,800 tons. The actual weight of the vessel will be about 10,000 tons inasmuch as the deadweight, comprising cargo and stores will be 10,190 tons.

The one nuclear engine will deliver 20,000 service horsepower for a cruising speed of 20 knots per hour. The crew on board will number about 65. There will be accommodations for 60 passengers.

Engineering work preparatory to the construction of the ship will start immediately in order to get an early start on the *Savannah*. The atom-powered ship will be built on one of the shipyard's eight ways, not far from the huge graving dock in which the aircraft carrier *Kitty Hawk* is taking shape.

The nuclear plant which is being prepared for use aboard the *Savannah* will be an advanced pressurized water design. Propulsion will be achieved by a steam turbine connected to one propeller shaft through double reduction gears. The operation of the entire power plant will be from a console located in an air-conditioned control room adjoining the machinery area.

Special provision has been made in the design of the experimental vessel in order to permit tours. This will allow visitors to view the ship's machinery while it is operating.

Long-Range Ballistic Missiles Photographed by New Optical System

ROTI (recording optical tracking instrument) is now being used to photograph missiles in the earlier stages of their flight after launching from the U.S. Air Force Missile Test Center's (AFMTC) Cape Canaveral, Fla., launching site.

The first of these intricate cameras, designed and manufactured by the Perkin-Elmer Corporation, Norwalk, Conn., and at present in the pre-acceptance stage by the AFMTC, is operational at Melbourne Beach, Fla., approximately 15 miles south of AFMTC Headquarters. A second unit will be installed at Vero Beach, Fla.

Primary instrument of the station is a large optical tracking instrument called ROTI Mark II which will permit the Air Force to measure the position of a missile moving in space and time with a greater accuracy than has heretofore been possible. The ROTI Mark II is one of a series of giant missile tracking systems.

The instrument consists of a 24-inch aperture primary objective telescope, sighting telescopes, camera, controls, and associated equipment. It weighs over eight tons and is mounted on a U.S. Navy 5-inch gun mount especially adapted for the purpose. The primary telescope has varying focal lengths between 100 and 500 inches. It is approximately two feet in diameter and eight feet long, weighs a ton, and incorporates some 200 different optical elements. A 70-mm camera with frame rates up to 60 frames per second is used with the system.

The Melbourne ROTI is one of four being built for AFMTC. A second data collection station is nearing completion at Vero Beach. Similar instruments are being built for other Air Force installations.

Construction of the data collection stations and the training of personnel to operate them is being done by the manufacturing firm. The RCA Service Corporation, which has technical supervision of the missile range, will operate the stations for the Air Force.

DETAILS of this Air Force plane are clearly visible although photograph was made by ROTI from a distance of 10 miles. Picture was taken at less than full focal length of system on high-speed 70-mm motion picture film.

How It Works

The Melbourne Beach ROTI data collection station will operate as an integral part of the Patrick range communication and tracking net. Information from radar and other communication nets will be fed into the station when a missile is fired. Computers at the station will convert this into information that will activate and adjust the ROTI. Corrections will be made automatically for parallax (difference in distance and line of sight from the radar to the station), and for the earth's curvature. The ROTI will be focused automatically and will also make automatic corrections as the sky background changes.

The ROTI station can be operated by remote control, or by range personnel employing "aided tracking." When operated by range personnel, the same information will be fed into the system. However, when the missile comes within sight, the operators will take over. With aided tracking, the operators need make only the simplest mental calculations and the slightest physical movements to follow the missile. The slightest hand pressure on a specially developed stiff-stick control will enable the operator to adjust the acceleration, velocity, and position of the telescope.

A complete, self-sufficient unit, the ROTI station has its own electronic and mechanical equipment, computers, dark room for developing film, maintenance section, and air-conditioning system. The tower housing ROTI is very similar to that of an astronomical observatory.

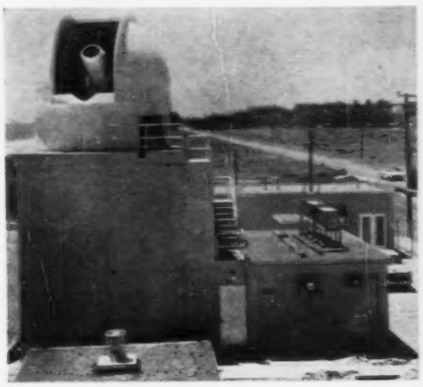
Photographic Information Provided

According to Dr. R. M. Scott, vice-president of Perkin-Elmer and general manager of its Engineering and Optical Division, systems such as ROTI provide essential information unobtainable by other means.

"Radio and radar give a certain amount of information on missile flight," Dr. Scott

Photos courtesy USAF and Perkin-Elmer

ROTI MARK II data collection station *(right)* will provide the Air Force with photographic information on flight performance of missiles. Electronic control console for the ROTI *(left)* built and installed by Perkin-Elmer at Melbourne Beach, Fla. The station has its own electronic and mechanical equipment, computers, dark room, air-conditioning system, and maintenance section. The ROTI system is the largest and most complex system of its type ever built.



stated, "but systems such as KOH provide an actual photographic record. Missile development is an expensive program. The more information that can be obtained about missiles, the more economically their development can be carried out, the faster they can be developed, and the better they can be built.

Another point made was to the effect that with a new missile, one can never be certain that it will make a successful first flight. Radar and radio will tell when the missile fails, if it does. But, by studying actual motion pictures of the missile in flight, it may be possible to tell why it failed. This makes a photographic tracking system a valuable commodity, especially when compared with the many scientific man-hours that could be spent probing for a missile's fault.

Radioactive Neutron Decay Flouts "Parity Conservation" Law

SCIENTISTS at the University of Chicago and Argonne National Laboratory (ANL) have proved, with the aid of an Argonne nuclear reactor, that the law of "parity conservation" does not apply in the radioactive decay of the neutron. The research was supported by the U.S. Atomic Energy Commission (AEC).

One of the most fundamental of nuclear processes is the radioactive decay of the neutron. Thus, this new work by the University of Chicago and ANL helps to clear the way for a reconsideration of current physical theories with the possibility of new and far-reaching discoveries regarding the nature of matter and the universe.

For nearly 30 years, the "principle of conservation of parity" has been a basic assumption among physicists. But earlier this year, it was demonstrated that parity did not hold for complex nuclei or mesons. These important experiments were carried out at the University of Chicago, the National Bureau of Standards, and Columbia University.

The joint ANL–University of Chicago research team worked about six months on the experiment. Special equipment was designed, built, and installed at ANL's Lemont, Ill., site to obtain the delicate measurements. The measurements were recorded over a three-week period in July 1957.

The neutrons used were "slow neutrons." Traveling at a speed of about 5,000 mph, they streamed from the ANL research reactor which is known as Chicago *Pile 5*.

Also, Morton Hamermesh, associate director of ANL's Physics Division, had invented a method of "filtering" a neutron beam in order to eliminate neutrons pointing the wrong way, and other unwanted radiation, such as gamma rays. Dr. Hamermesh's method reflects the beam off a polished "mirror" of cobalt magnetized in the right direction.

The decays of the neutrons were detected in a vacuum chamber by methods similar to those used previously at the Oak Ridge (Tenn.) National Laboratory and Chalk River (Ont.) Laboratory to measure the lifetime of the neutron.

This method used a fast electron detector with a plastic scintilator. The counts of this detector are recorded if they coincide with a count in a special detector, which is an electron multiplier with a large first surface of beryllium copper sensitive to the protons from neutron decay after they are accelerated to an energy of 10,000 volts.

This measurement permitted the physicists to discriminate among several competing theories describing radioactive decay by electron emission. The most promising theories vary in their predictions with a measured ratio ranging from about 21 to 100%.

Even so, none of these theories appears to be in complete quantitative agreement with the experimental result, a fact which the psysicists point to as illustrating the present uncertain state of understanding of nuclear physics.

After the giant accelerators enabled physicists to disrupt the nucleus of the atom with "bullets" of tremendous energy, they produced a score of nuclear fragments. Many of these did not behave according to the principle of parity. Instead of neat balance of left-handed and right-handed "spin" among the particles, some showed a predominance in one direction.

Then, two University of Chicago trained physicists, Professors Tsung Dao Lee, of Columbia University, New York, N. Y., and Chen Ning Yang, of the Institute of Advance Studies, at Princeton, N. J., challenged the validity of the parity principle, proved their theory, and won the Nobel Physics Prize.

They advanced theoretical considerations that it was the law and not the nuclear fragments that provided the stumbling block. They also suggested three experiments which should prove whether parity existed for mesons or complex nuclei such as that of cobalt. The three early-1957 experiments were those so suggested.

After these experiments, physicists speculated that if the parity principle did not apply in the subatomic particles, neither would it apply to the decay of neutrons, a fundamental unit of the atom, as are electrons and protons.

The simplest of all nuclei, the free neutron, is indeed itself known to undergo such a decay process. Thus, all theories proposed to explain the results of the NBS experiments primarily make statements about the neutron, and only apply to more complicated systems, such as the cobalt nucleus, only indirectly. But the "parity law" had never been demonstrated to fail in the case of the neutron itself. Physicists from ANL and the University of Chicago showed precisely this failure by a technically difficult experiment which lay in the fact that one has to observe the decay processes within a limited volume. Whereas ordinary radioactive atoms, such as cobalt used in the NBS experiment, can easily be concentrated in a tiny spot of solid material, neutrons form a sort of dilute, invisible gas that oozes out of the sides of nuclear reactors and cannot be compressed by any known means into a tiny volume. This "gas" flows at high speed through the volume under observation, and very few neutrons will decay during the hundred-thousandths of a second or so that they spend in that volume.

NBS Radiotelescopes Track Satellite's Signals

The Boulder Laboratories of the National Bureau of Standards (NBS) mobilized its resources and set up a crash program to make use of the Soviet satellite as long as it circled the world or until its radio batteries died. The objective of their fast-moving program was to learn more about the mysterious ionosphere that surrounds our earth at heights up to about 300 miles.

By a simple extension of work already being carried out under several projects, it was possible to rush a program into action. One of these projects is based at Table Mesa, a site 10 miles north of Boulder.

The site was set up for observing radio energy emitted by the star Cygnus. By an adjustment of equipment engineers were able to monitor the signals from *Sputnik I* at both 20 and 40 megacyles.

Because radio waves are bent more by the ionosphere at 20 than at 40 mc, the satellite appears to be at different locations at the same time at each of these frequencies. By studying this effect, the NBS scientists expect to gain much knowledge about the amount of ionization the satellite is passing through as well as other characteristics of this ion media which is all important to the transmission of radio waves.

When the satellite enters the radio horizon of the receiver, the frequency of its transmitter is upped as much as 1,000 cps and as it leaves the frequency is lowered by the same amount. This means that by comparing the actual frequency recordings with the standard tones of frequency and time issued regularly by the NBS radio standard station WWV, scientists will be able to find the satellite's exact velocity and the time it is closest to us.

The eventual continuous tone given by the Soviet satellite was an improvement over the previous beeps, it was revealed. Studying the satellite as it passed over the Western Hemisphere, two large radio telescope dish antennas that form an interferometer unit were used. The beeps were a decided nuisance because they represented a varying signal on the graph recordings, thus getting mixed in with the varying signal which the dish antennas were artifically introducing for scientific reasons. The result was very difficult to disentangle.

Studying the rapid changes and "bunch-

ings" of ionization in the ionosphere, to radio signals that go through the layers involved, was the experiment set up using the star Cygnus as a source.

Then came the satellite which had radio signals much stronger than those received from the star because it is nearer to earth and, therefore, much better for some parts of the radio signal work.

From the data gathered, it is expected that, using this tool, further information about the structure of the far reaches of the upper atmosphere will provide precise information on how much the radio waves are bent in going through the ionosphere.

Radio receiving equipment developed and used to pick up radio signals from the planet Jupiter (*Electrical Engineering*, July 1957, p. 650) was called into play to track the satellite on 20 mc. These first interferometer measurements of *Sputnik I* made on improvised apparatus which was hastily assembled to study the satellite on 20 mc were abandoned as soon as the phase switching interferometer that is similar to the equipment used to pick up the satellite's 40-mc signal was put into action.

This receiver lifted the satellite signal out of its background of all kinds of other cosmic noises and made its radiowaves clearly distinguishable from most other interferring radiations.

Comparisons of the two signals will enable pinpointing the amounts by which radiowaves are bent when they come through the ionosphere.

An additional team of scientists set up shop at Table Mesa to make another kind of measurement. This group set up a field laboratory with headquarters in a trailer, to make measurements of the turbulent structure of the ionosphere using the moonlet as a tool.

They modified equipment ordinarily used to study the structure of the lower regions of the atmosphere. By sending out radiowaves overland, distances that ranged from 3½ to 60 miles, and receiving the signals at antennas spaced a certain distance apart, the men were able to compare the received signals and to determine the relative amount of turbulence each of the signals had encountered in the troposphere, the lower part of the atmosphere.

Never before the satellite, however, did they have a transmitter above the ionosphere that could send radiowaves on a specific frequency down through the ionosphere while constantly moving into different locations in reference to the ionosphere.

Other scientific projects at the Boulder Laboratories have been able to study certain things about the ionosphere, such as how radiowaves are bent, by studying the radio energy coming from radio stars and from the planet Jupiter. But there have been definite limitations in using this technique as far as the measurements of ionospheric turbulence are concerned. These radio stars and Jupiter emit on all frequencies and it is virtually impossible to block out all but a specific frequency. With the satellite, it is relatively easy to get very good measurements that can be analyzed in the months to come.

Inasmuch as both the earth and the satellite are moving constantly, each record was of a different region of the ionosphere. Because of this fact, the scientists essentially were measuring ionosphere turbulence from many different angles and the information gained should be extremely beneficial to radio scientists all over the world.

With orders to drive a mobile trailer unit at least 500 miles north of Boulder and to start recording signals from *Sputnik I*, a third group of technicians stationed themselves near Miles City, Mont.

The men collected additional information that can be correlated with satellite measurements being made at Table Mesa.

As soon as the recording equipment was placed in operation, following the announcement that the Soviets had a satellite aloft, Doppler shift measurements were being made.

These are measurements of the decreases in the frequencies received from the satellite as it swishes into the receiver range then retreats into the distance.

This entire process takes place within one or two minutes, and it has been noted that the closer the traveling broadcasting object comes to the receiver, the more rapidly the frequencies will vary from maximum to minimum.

This information is vital for two reasons: (1) to determine how much ionization was present in the areas where the satellite passed through and (2) to learn more about how radiowaves will be reflected by the ionosphere over long distances.

For some time scientists have been using various techniques to try to map the vast upper reaches of the atmosphere according to the density of ionization present at various latitudes and at various times of the hour, day or season. The satellite is now providing them with an extremely effective tool.

The more man knows about the ionosphere, the more accurately will he be able to predict radio conditions and to design equipment capable of operating under the most varied of propagating conditions.

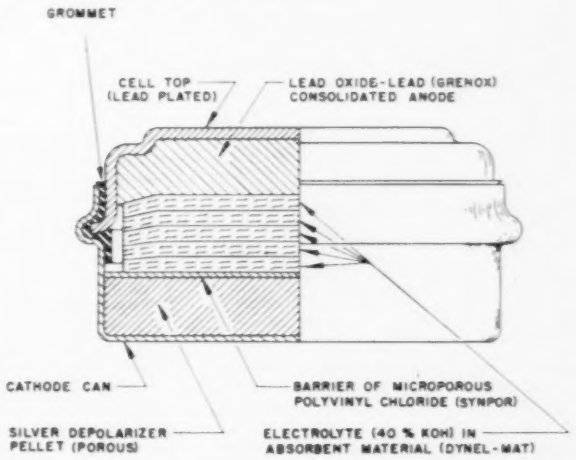
Measurement of ionospheric densities is important because man-generated radiowaves are bounced long distances

Unique Lead-Silver Rechargeable Dry Battery

With a potential storage life of 10 to 15 years, a unique lead-silver rechargeable dry battery has been perfected at the Naval Ordnance Laboratory (NOL), Silver Spring, Md., to power certain new underwater devices.

When it is compared with the conventional dry-cell battery, the 0.6- by 1.2-inch unit weighs 40 grams as against an approximate 95 grams for the vastly larger flashlight battery. Its fully consolidated, unusually rugged structure enables it to withstand mechanical shock to 3,500 g. The battery, called "Mighty Midget," delivers a nominal open-circuit voltage of 0.9 volt at a rated capacity of 1,500 milliampere-hours. It may be stored in the uncharged condition at either high (+165 F) or low (−65 F) temperatures for long time intervals and, when subsequently charged, it is virtually indistinguishable from a new battery. It is capable of maintaining constant voltage over a period of years at standby conditions and yet can withstand sudden drains of several milliamperes without excessive voltage drop. When the cell is charged at 1.12±0.03 volts, the silver cathode shown in the illustration is converted to silver oxide and the lead monoxide–lead anode is converted to metallic lead. The limiting charge is that of the silver cathode.

For this reason, the nominal electrochemical system of this alkaline battery is $Pb/KOH(40\%)/Ag_2O$. The polyvinyl chloride (Synpor) barrier and the highly efficient Dynel absorber material are unique to this battery. To increase the rechargeability of the basic cell greatly, NOL scientists have made a successful experimental modification which involves painting the interior of the cathode case with a thin layer of Polyco. Circuits of considerable voltage and amperage can readily be built up by arranging the cells in series or parallel banks. Charging is accomplished with a battery charger having a voltage regulator.


GROMMET
CELL TOP (LEAD PLATED)
LEAD OXIDE-LEAD (GRENOX) CONSOLIDATED ANODE
CATHODE CAN
BARRIER OF MICROPOROUS POLYVINYL CHLORIDE (SYNPOR)
SILVER DEPOLARIZER PELLET (POROUS)
ELECTROLYTE (40 % KOH) IN ABSORBENT MATERIAL (DYNEL-MAT)

Official Photograph, U.S. Navy

Members of the NOL Acoustics and Electronics Division invented the new cell which has been granted a patent prior to release.

around the world as they strike the ionosphere and rebound to earth. The frequencies at which they bounce depend on the relative density of ionization. The 40-mc signals of the satellite were more inclined to come through the ionosphere whereas the 20 mc, at times of high ion density, bounce back into outer space.

At Miles City, propagation conditions for the satellite's signals were not as favorable as those at Table Mesa because Miles City is much closer to the Arctic Zone where radically different propagation conditions are found as the ionosphere thins out. This is one reason why the technicians were told to drive north, so that scientists could learn even more about the ionosphere's varying propagation conditions at a different latitude by means of the satellite as a tool.

Also, like surveyors, they know that the more points from which the study of the same phenomenon can be made, the more valuable is the resulting information.

Strange Crystals May Explain Steel Failure

Crystals, which grow as delicate plates from the surface of stainless steel, may explain a destructive failure of the metal known as "stress-corrosion cracking."

This new theory was revealed by an international authority on corrosion, Dr. E. A. Gulbransen, advisory chemist at the Westinghouse Research Laboratories, Pittsburgh, Pa. Dr. Gulbransen spoke before the 2nd World Metallurgical Congress, at the International Amphitheatre, Chicago, Ill., under sponsorship of the American Society for Metals.

Stress-corrosion cracking can occur in metal structures which are chemically corroded while under an internal or applied stress, such as a pull or twist, which can cause complete failure of the structure. Stress-corrosion cracking can be triggered even by such mildly corrosive substances as steam or human perspiration; and it occurs in objects subjected only to the internal stresses left in them during their manufacture. Stainless steel pipes, turbine blades—even coffee urns and cooking vessels can fail by stress-corrosion cracking.

Dr. Gulbransen described the newly discovered crystals as "submicroscopic platelets of chromium oxide." They form on strongly stressed stainless steel specimens which are exposed to corroding atmospheres containing traces of negatively charged chlorine atoms—more properly referred to as chloride ions.

Working with Dr. Gulbransen in the experiments which led to the new theory were T. P. Copan and Dr. Daniel van Rooyen, research engineers at the Research Laboratories. The experiments are inherently quite simple, but extremely delicate and precise.

In a typical experiment, a small piece of stainless steel wire, nine thousandths of an inch in diameter and subject only to the residual stresses it normally possesses, is exposed to a carefully controlled atmosphere of oxygen and water vapor at a red-hot temperature of 1,100 F.

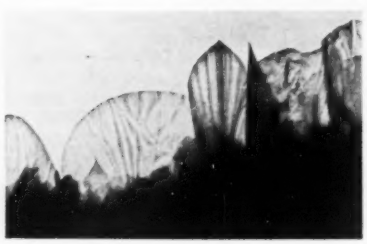
A small disk of stainless steel, five thousandths of an inch thick and having a hole six thousandths of an inch in diameter, substitutes for the wire in some experiments. After corrosion by the hot atmosphere, the wire or disk is examined and photographed with an electron microscope. The pictures which result are startling.

Using very pure oxygen and water vapor, the surface of a typical sample of stainless steel erupts with billions of oxide "whiskers." Only about one or two millionths of an inch in thickness, these whiskers grow to a height 300 or 400 times their diameter. Their density is about 6 billion per square inch of metal surface. These dimensions can be visualized by imagining a three-foot chimney built to a height of 1,000 feet. The vast number of whiskers on the metal surface is apparent when it is realized that the average human head of hair contains only about 100,000 hairs.

"Completely unexpected changes occur in this crystal growth simply by prestressing the stainless steel and adding only the slightest trace—less than five parts per million—of chloride ions to the atmosphere," Dr. Gulbransen said. "Instead of long thin filaments, we discover rows of thin, upright, parallel plates growing along a definite crystallographic direction."

Under the electron microscope, these crystals are easily penetrated with a 60,000-volt beam of electrons, placing their thickness at half a millionth of an inch or less. Analysis shows them to have the characteristic structure of an oxide of chromium, Cr_2O_3. Chromium is a metal normally present in stainless steels, and each tiny plate appears to be a single crystal of its oxide.

For some time, scientists have known that the chloride ion is a major factor in producing stress-corrosion cracking of stainless steel. It would now appear that chloride ions could stimulate the growth of these unique, plate-like crystals in a strongly stressed metal, which growth might result in cracking and the ultimate failure of the steel.



OXIDE WHISKERS *(left)* grow on surface when stainless steel is high-temperature corroded by pure water-vapor and oxygen mixtures. Photograph, made with electron microscope, is magnified 11,200 times. Delicate crystals *(below)*, magnified 9,000 times, erupt from stainless steel surface in corrosion studies. Scientists believe these cut tiny canyons in metal's surface causing stress-corrosion cracking.

Pressure Conditions 95 Miles Up Simulated

The existence in Beverly Hills, Calif., of an Inhabited High Vacuum Laboratory which has already simulated the pressure conditions that prevail 95 miles above the Earth was publicly confirmed in a joint announcement by the U.S. Air Force Office of Scientific Research (OSR), sponsors of the project, and Litton Industries, electronics firm which conceived and designed the new laboratory.

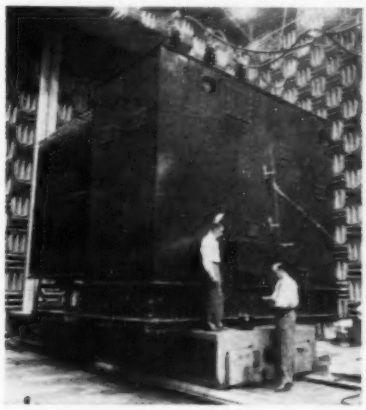
Pointing out that the laboratory is an invaluable research tool in performing fundamental studies needed for the development of ultrahigh-altitude weapons systems, Gen. H. F. Gregory, Commander of the Air Force OSR, described the new facility as consisting of a chamber, 8 feet in diameter by 15 feet long, and an especially developed pressure suit which permits researchers to observe and control experiments inside the vacuum chamber. Two huge pumping systems remove the air from the chamber, leaving only one out of every 18 million molecules of air within the steel cylinder, thus achieving a vacuum the equivalent of 528,000 feet above the Earth. Protected by the unique pressure suit with its external system of oxygen-supply and heat-removal, an operator can inhabit this vacuum and perform intricate research.

The development of the new Air Force—industry research tool was monitored by the OSR Directorate of Advanced Studies in Pasadena, Calif. According to Dr. Morton Alperin, head of the Directorate, the laboratory will be used to facilitate the advancement of knowledge about the behavior of physical phenomena, equipment, and instrumentation under conditions of extremely low pressure and density, knowledge which is prerequisite to the development of high-altitude weapons systems. As examples of the areas scientists can now explore, Dr. Alperin listed: the working of lubricants in ionospheric environments where common lubricants are known to vaporize; the operation of gears, sliding contacts, and other such devices when established concepts of friction are altered by the lack of an air-layer between the contact surfaces; and the absorption and reflection of radiant heat in the absence of surrounding air. With the new laboratory, it also becomes practical to test the extraterrestrial reactions of com-

ponents, materials, and human protective equipment to such radiation as unfiltered sunlight, X rays, and ultraviolet rays beamed in through portholes in the vacuum chamber.

Power Transformers with Low-Sound Enclosures

Power transformers of 10,000 kva and up are now available with sound-deadening enclosures from the General Electric Company's (GE) power transformer department.



ENGINEERS test sound levels of 10,000-kva, 69-kv power transformer equipped with new aphonic enclosure. Preassembled steel hoods and use of batts of sound-absorbent material reduce GE transformer sound 15 to 21 db below recommended levels.

The factory-built, steel hoods are fitted over the transformer tank and give reductions of from 15 to 21 db in audio sound levels. The resulting sound energy is only 3% or less of the original audio level.

Prices of these aphonic enclosures are generally below the costs of other methods of achieving these sound levels which are appreciably below NEMA (National Electrical Manufacturers Association) standards, department officials said.

The department has built or is building transformers rated 10,000, 25,000, 35,000, and 70,000 kva—including 13 for one major metropolitan utility—with this method of sound reduction.

The enclosures were developed after extensive research and testing in GE's sound laboratory in Pittsfield, Mass., where the first large anechoic chamber for testing power transformers was built.

The enclosures are assembled on the transformers in the factory. Batts of sound absorbent material in the air space between the enclosure and the transformer tank also help muffle sound which is attenuated in all directions. Cooling efficiency is maintained, since coolers are outside the enclosure, connected to the tank by flexible piping to reduce sound transmission to the cooling equipment. Doors and windows are provided for easy inspection and maintenance. They can be had with or without load tap change units and for use with switchgear.

Improved Method of Cooling Electronic Equipment

An improved method for cooling electronic equipment on board ship has been under study at the National Bureau of Standards (NBS). The method is based on transferring heat from the equipment cabinet through an intermediate coolant to sea water as the ultimate heat sink. Although undertaken for the U.S. Navy Bureau of Ships by P. Meissner of the NBS staff to solve a special design problem in heat transfer, this technique could be applied to other than shipboard equipment, and tap water could be used instead of sea water.

The rapidly increasing use of electronics aboard modern naval vessels has placed increased demands on shipboard cooling equipment. Present-day equipment relies for cooling primarily upon compartment air provided by the vessel's ventilating and air conditioning system.

The NBS study was concerned with a system that would be readily applicable to existing equipment of conventional construction. Present equipment is cooled primarily by air convection. If the equipment cabinets were enclosed and the air within the cabinet recirculated, a closed forced-convection system could be obtained. An air-to-liquid heat exchanger located within the cabinet could transfer heat from the air to an intermediate coolant, which, in turn, would give up its heat to sea water. By using an intermediate coolant, such as fresh water, the practice of piping sea water about the vessel could be avoided. The feasibility of this method depends largely on whether the equipment can be maintained at safe operating temperatures in locations where sea water is at its warmest.

The temperature of sea water ranges from −2 to +30 C. The intermediate coolant is, therefore, available at an upper limit of about 35 C, while cooling air can be supplied to the equipment at about 43 C. The temperature differentials are necessary for the efficient operation of the heat exchangers. Because there are many military-approved components suitable for operation at 43 C, this temperature would seem to be a safe upper limit. However, the temperatures of components inside large, dense equipment may be much higher than for components operated singly out in the open. Inasmuch as natural convection cannot be relied upon, the application of forced convection was investigated.

It is not difficult to achieve the desired sequential air-flow pattern, since much existing equipment already incorporates the necessary component part grouping to a considerable degree. In the case of standard chassis construction, it is customary to mount vacuum tubes and transformers on the upper side of the chassis, while such smaller components as capacitors, diodes, and low-wattage resistors are mounted underneath. The required airflow pattern is easily obtained by drilling holes through the chassis around the base of each heat-producing component, enclosing the bottom of the chassis, and supplying air under slight pressure to the space within the chassis. One component which does not generally fall into the desired grouping is the electrolytic capacitor. Because of its large size, this component is frequently mounted on top of the chassis, and is thereby subjected to high temperatures resulting from its proximity to vacuum tubes and other sources of heat. Where it is necessary to mount this component above the chassis, it can be kept cool by surrounding it with a reflective metal baffle and placing a few perforations through the chassis around the base of the capacitor.

The aforementioned method of applying forced convection was developed and evaluated experimentally on a console containing a number of conventional components assembled using standard chassis construction. It was determined that all components could be kept within safe operating temperatures with cooling air at an inlet temperature of 43 C. An air temperature rise of 10 C was obtained using an air flow rate of approximately 200 cubic feet per minute. Electric power input to the console was about 1,200 watts. The console was completely closed and insulated to reduce the interchange of heat between the console and its environment. An air-to-liquid heat exchanger served to transfer heat from the circulating air to a flow of cooling water.

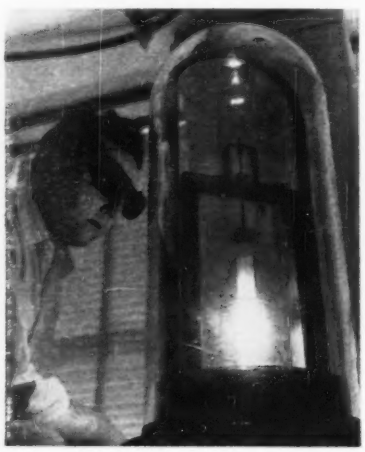
INTERIOR VIEW of modified equipment cabinet—with all chassis removed—showing internal design for heat dissipation. In this cabinet, all openings are blocked off, exhaust hoods have been installed for removing warm air, the sides are insulated with a 1-inch layer of glass wool covered with aluminum foil, and sheet metal trays have been put in to support all chassis and to provide flow paths for incoming air.

Technique Developed for Preparation of Niobium

Niobium has moved a step closer toward its expected use in rockets, missiles, jet engines, and nuclear reactors of the future, it was stated by Westinghouse scientists who have developed a technique for the preparation of this rare and little-known chemical element. Preparation of the metal in its purest possible form is essential to a basic understanding of the properties that make it of interest as a high-temperature structural metal. The high-purity niobium was produced by a metallurgical process discovered at the Westinghouse Research Laboratories near Pittsburgh, Pa., and called "cage zone melting." It has produced the purest niobium ever made on a scale large enough for realistic scientific study of the ultrapure metal.

Making of the pure niobium and investigation of its physical and chemical behavior is a joint effort of scientists and engineers from three Westinghouse facilities—the Research Laboratories, the Materials Engineering Department, and the Aviation Gas Turbine Division. The work centered at the Westinghouse Research Laboratories is being done in cooperation with the U. S. Air Force's Wright Air Development Center.

In announcing preparation of the extremely pure niobium, Dr. Clarence Zener, director of Westinghouse research, stated that rigid demands imposed by all forms of supersonic flight and tremendous temperatures made available by release of nuclear energy have intensified greatly the need for such materials. Over the past decade the development of iron-, nickel- and cobalt-base "super" alloys having excellent strength at temperatures up to about 1,700 F have been developed. For higher temperatures, the metallurgist has turned, in recent years, to the higher melting point "transition" metals such as chromium, molybdenum, and tungsten.



BAR OF NIOBIUM is purified in process called cage zone melting. The bar melts from the inside out as it rises through a coil carrying high-frequency alternating current. Molten metal moves along the bar, trapped by the bar's four unmelted corners. Entire process must be carried out in a large glass vessel with a vacuum only four billionths the pressure of atmosphere.

Member of this family of metals, niobium was formerly called columbium. It is a comparatively rare element, of relatively minor commercial importance.

Research has been directed toward a fundamental study of the element, its behavior at elevated temperatures, and the development of potentially useful niobium-base alloys for very high-temperature applications.

Niobium has unique high-temperature properties. Unlike most metals, it does not lose its room-temperature strength drastically with increasing temperature. At 2,000 F—just about the melting point of copper—it has roughly the same strength as molybdenum and is several times stronger than the best available nickel-base and cobalt-base alloys at this temperature. Niobium also has valuable structural characteristics. It is only slightly heavier than iron, and is not brittle at room temperatures as are other high-temperature metals such as chromium and molybdenum.

Because it is very active chemically near its melting point of 4,380 F, molten niobium must be handled in a vacuum or in an atmosphere of some inert gas such as helium or argon. For the same reason, niobium of extreme purity cannot be prepared by melting it in any sort of crucible or similar container.

As the bar rises through the coil, a molten zone of niobium travels down the bar from top to bottom, melting the bar progressively throughout its entire length. Successive "passes" through the coil result in niobium of increasing purity as more and more impurities are removed.

In addition to the preparation of the ultrapure metal, the research program on niobium includes such studies as: tests of the strength of the metal at temperatures ranging from +2,000 to −320 F, measurements of the rate of niobium oxidation at elevated temperatures, method of welding the metal under various kinds of gas atmospheres, and improvement in methods of analysis for trace impurities in the metal.

Recently, large reserves of niobium ores have been discovered which supply could take the metal out of the "rare metal" classification it has held for 150 years. Strangely enough, niobium was discovered that long ago in a sample of ore which the first governor of Connecticut, John Winthrop, sent to England more than a century before. Now, after all this time as a little-known and little-used element, niobium seems about to emerge as a valuable structural metal of the future.

Signals Bounced from Meteor Trails

High-frequency radio signals, bounced from meteor trails 60 to 100 miles above the earth, have been used experimentally for the first time to transmit images of printed material over a distance of nearly 1,000 miles without relays, it was disclosed today by the Radio Corporation of America (RCA).

The disclosure came in a report by three RCA Laboratories scientists that special facsimile equipment has performed successfully in preliminary tests of meteor-path propagation between the transmitting station of the National Bureau of Standards (NBS) at Havana, Ill., and the RCA Laboratories radio research installation at Riverhead, L. I., N. Y. This is an airline distance of 910 miles.

The novel system was developed for the Cambridge Research Center of the Air Research and Development Command (ARDC). Principals in the development were W. H. Bliss, of the technical staff at RCA's David Sarnoff Research Center in Princeton, N. J., and R. J. Wagner, Jr., and G. B. Wickizer, of the RCA Laboratories radio research staff at Riverhead.

Basic research in the field of meteor trails has been conducted in the United States notably at Stanford University, Calif., and the NBS, much of it sponsored by the Department of Defense, as well as in Canada and the United Kingdom. In recent years, more attention has been given to the effects of meteor reflection on communications. The Canadian Research Board developed a teletypewriter system.

Because radio reflections from meteor trails were believed to be of importance to the U.S. Air Force, the Propagation Laboratory of The Cambridge Research Center had initiated a meteor program in 1953. As a result of this program, Dr. Philip Newman and Dr. Joseph Casey of the Cambridge Center came to the conclusion that it should be possible to make radio transmission of visual material via meteor trails. RCA, at the request of the Air Force, developed special equipment to investigate this possibility. The first trail of this equipment during early Autumn met with instant success. However, the meteor trail phenomenon is a complicated one and considerable further research will be required to determine how best to exploit this new capability.

The RCA scientists explained meteor trail propagation as follows: When a meteor enters the thin upper atmosphere of the earth, the high velocity of its passage causes the air particles to break down into positive and negative ions. This trail of ionized air, which may persist during a time interval ranging from one-tenth of a second up to several minutes after the passage of the meteor, acts as a reflector of radio signals which would otherwise radiate out into space. Along a transmission path of the type used in the experimental facsimile system, ionized meteor trails appear on an average of several times a minute to close the circuit between transmitter and receiver.

The research team pointed out that meteor path propagation promises ultimately to increase the versatility of all radio communications by providing a means of sending information at times and over distances for which other means may not be available. It also offers a valuable means of supplementing the overcrowded radio spectrum.

According to the report of the three scientists, the experimental RCA system functions in the following manner.

The material to be transmitted is recorded on 35-mm film, which is scanned to produce a signal in a manner similar to the techniques used in television film transmission. The resulting signal is sent out from the transmitter through a highly directive antenna aimed in the direction of the distant receiver. At the receiver, the signal is picked up by another directive antenna each time it is reflected during the brief life of an ionized meteor trail, and the information is fed to a cathode-ray tube for display on a viewing screen. In the experimental system, photographic techniques are used to record the image as it appears on the screen.

The research team reported that the scanner and transmitter are run continuously, sending copies of a picture over and over at the rate of two complete scans each second. The receiver is also on continuously with the recording unit in a "standby condition."

"When a passing meteor closes the transmission path, the incoming signal trips the recorder . . . to permit reproduction on the phosphor screen," it was stated. "The circuit then resets for the next burst."

The report said that the experimental transmitter produces 20 kw of power at a frequency of 40 mc, which is in the very-high-frequency range somewhat below the portion of the frequency spectrum used for commercial very-high-frequency television service. It added that the "encouraging results" thus far have been achieved during preliminary tests of the new equipment prior to the start of a planned research program.

Automatic Landing System Successfully Lands Navaho *X-10*

A completely self-contained, automatic landing system (ALS) has been developed and successfully tested by Autonetics, a Division of North American Aviation, Inc., the U. S. Air Force announced recently.

Originally designed for the supersonic North American *X-10* unmanned test vehicle, the all-purpose ALS, according to Autonetics, operates by automatically flaring an aircraft through a predetermined path to touchdown. For complete automatic control, the system provides "fly-up" or "fly-down" signals that are coupled to the autopilot. Flare can be triggered by the system at any altitude up to 500 feet.

It was disclosed that during development, the system successfully handled more than 400 automatic, or "hands off" landings in both manned jet aircraft and unmanned missiles.

The system has also demonstrated successful landings in subsonic and supersonic aircraft, and is said to be ready for use in a wide range of high performance, airborne vehicles. It may also be used with ILS (instrument landing system) or GCA (ground control approach) methods to provide all-weather landing capabilities and is further adaptable to hovering-type aircraft, according to company personnel.

This ALS was developed originally to provide smooth but firm landings for a high-performance missile. Rate of descent, as a function of absolute altitude, is controlled by flare signals generated by the system. Such control determines the proper space path for descent and also provides a predetermined low rate of descent at touchdown.

When used in the *X-10* under conditions of a 10° glide-angle approach, sinking rate is decreased from 4,200 feet per minute, or 70 feet per second, to a mere one or two feet per second at touchdown. Flexibility of the system has been demonstrated by repeated, successful landings over a wide range of approach airspeeds and sinking rates, indicating adaptability to other manned or unmanned aircraft.

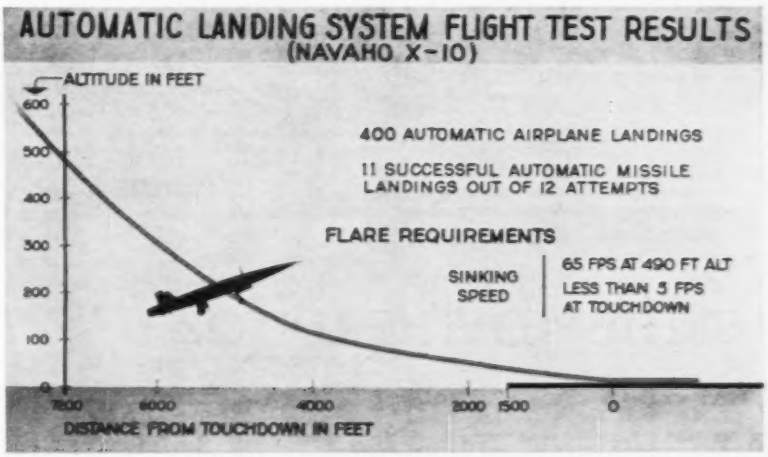
Events of Interest to Electrical Engineers

National Electrical Week. The official listing of this event as it appears in the 1958 edition of "Special Days, Weeks and Months" a publication of the U. S. Chamber of Commerce reads as follows: "*Electrical Week National.* Feb. 9-15. (Scheduled annually for week of Thomas Alva Edison's birthday.) Sponsor: National Electrical Week Committee, 290 Madison Ave., New York 17, N.Y., representing the major trade associations in the electrical industry. Purpose: To enhance public appreciation of electricity and the contributions of the electrical industry to the Nation's progress and economy."

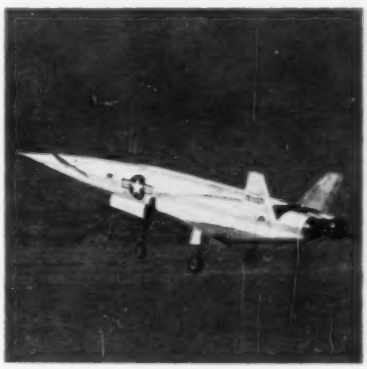
International Convention on Microwave Valves. The Committee of the Radio and Telecommunication Section of The Institution of Electrical Engineers, Savoy Place, London W.C. 2, England, with the approval of the Council, have made arrangements for an International Convention on Microwave Valves to be held in the Institution Building May 19-23, 1958.

The proceeding will be opened by the President. A detailed program is available upon written request.

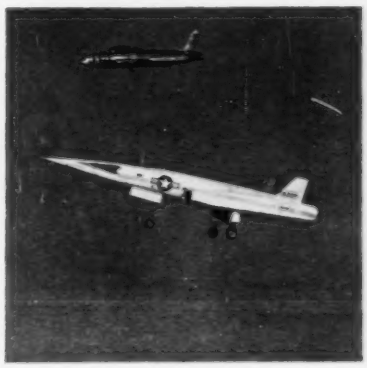
A cordial invitation is extended to all to be present at the sessions, and the names of any who will be able to attend should be sent to the Institution Secretary.



ALS DIAGRAM gives details from data gathered in 400 plane and missile flights and landings which used the Autonetics system with great success. The system can be used with the ILS or GCA methods and can be modified for use in hovering aircraft.



HANDS OFF landing is demonstrated using the new ALS (automatic landing system) developed by Autonetics, Division of North American Aviation, Inc., to touchdown the X-10 unmanned supersonic test missile.



MANNED aircraft and unmanned missiles use newly developed ALS, a self-contained system, which has ben used successfully in more than 400 test landings. The system was developed for the Navaho X-10.

Notification of attendance at the meeting should be sent to W. K. Brasher, Secretary, The Institution of Electrical Engineers, Savoy Place, London W.C. 2, England.

The Society of Nuclear Medicine. The fifth annual meeting of The Society of Nuclear Medicine will be held in Los Angeles, Calif., at the Beverly Hilton Hotel, June 19-21, 1958.

The Executive Committee and the Board of Trustees will meet at the Beverly Hilton Hotel on June 18—time to be announced later.

February 15, 1958, is the deadline for submission of abstracts to be published, and March 1, 1958, is the deadline for submission of manuscripts for papers to be given on the program. Send titles, abstracts, and manuscripts to the chairman of the Program Committee, Dr. G. C. Kyker, ORINS Medical Division, P.O. Box 117, Oak Ridge, Tenn. One original and one carbon of a 200-word abstract typed on a single sheet of paper are required.

Make your reservations for the Beverly Hilton Hotel now—repeat *now!*

High-Speed Memory Unit Uses Superconductivity Principle

Low temperature physics research work has resulted in the development of a very high-speed computer memory element which makes use of low temperature superconductivity principles to achieve both storage of information and instantaneous switching.

The newly developed device is called a Persistor (registered trade mark) and is a miniature bimetallic, printed circuit which operates at a temperature within a few degrees of absolute zero (—459.6 F). It requires very little power for operation and has been designed with switching times as short as 10 millimicroseconds (1/100 millionth of a second).

The Persistor was designed for use in the memory unit of an electronic computer, and improves the access time to the memory 10 to 100 times over present methods. This increase in speed permits an improvement in balance between the arithmetic and memory units in the computer.

The new unit makes use of the superconductivity phenomenon exhibited by various metals at low temperatures in order to achieve both the switching and signal storage functions required of a computer memory element. Essentially, the Persistor is a loop composed of segments of two metals, both of which are maintained in a superconductive state at a very low temperature. One segment of the loop is of a metal so chosen that the passage of a small current (the critical amount depending on its temperature) through it causes it to change from superconductive to its normal resistance state. A subcritical current is induced in this loop and continuously circulates around it for an indefinitely long period, the direction of this current representing the information being stored.

Direction of the current in the loop is determined at any time by impressing an interrogating current pulse on the bimetal loop.

LETTERS TO THE EDITOR

INSTITUTE members and subscribers are invited to contribute to these columns expressions of opinion dealing with published articles, technical papers, or other subjects of general professional interest. While endeavoring to publish as many letters as possible, *Electrical Engineering* reserves the right to publish them in whole or in part or to reject them entirely. Statements in letters are expressly understood to be made by the writers. Publication here in no wise constitutes endorsement or recognition by the AIEE. All letters submitted for publication should be typewritten, double-spaced, not carbon copies. Illustrations should be submitted in duplicate, one copy and inked drawing without lettering, the other lettered. Captions should be supplied for all illustrations.

Calder Hall

To the Editor:

Page 864 of the October 1957 issue of *Electrical Engineering* contains a short article under the heading "Atomic Power Spindle." It refers to "A steam turbine spindle which has been manufactured for the world's first nuclear power plant in Shippingport, Pa."

Constant criticism of this country's unwillingness or inability to publicize its achievements overseas causes me to write this letter and to refer you to the fact that a nuclear power station at Calder Hall, Cumberland, England, went critical in October 1956, and since that date has been supplying electric power into the British national grid system.

Two further nuclear power stations are at present under construction in this country and work on a third of 500 megawatts will begin shortly. The construction of a fourth site in Scotland will also begin shortly.

I believe Calder Hall to be the world's first nuclear power station and to publish claims which do not recognize its existence is hardly calculated to flatter the intelligence of your readers.

Yours faithfully,

R. H. VEYSEY
(Assistant to Chairman)

EDITOR'S NOTE: This statement got into print through an oversight on our part for which we apologize.

Tesla Homeland Visited

The following is a letter received from K. M. Swezey (AFFIL '56) who has been traveling in Yugoslavia. Mr. Swezey is a science and engineering writer. He was a close personal friend of Nikola Tesla and is probably the outstanding Tesla student and biographer actively working in the field, at present.

Nikola Tesla Museum
Proleterskih Brigade 51
Belgrade, Jugoslavia

Dear Mr. Hibshman:

Everything goes well, and I have been having a wonderful and rewarding time, since I left New York in August. On my way here, I visited The Institution of Electrical Engineers and the Royal Institution in London, England, and saw the famous lecture theater, of the latter where Faraday, Crookes, and our friend Tesla lectured and Sir Lawrence Bragg now carries on. At the Deutches Museum in Munich, West Germany, I saw a Paris Edison Co. dynamo that had been installed in the railroad station at Strassburg and which Tesla repaired, in about 1882, before he came to America. The director of electrical engineering exhibits at the Museum took me through his store room of surplus equipment with the thought that I might help arrange a possible exchange of some of this equipment, which is mostly European, with the Smithsonian Institution, or other American group, for surplus equipment there. The Smithsonian has asked me to keep an eye open for anything of interest to them.

My reception in Jugoslavia has been almost overwhelming. Since my arrival here, I have been the guest of the Nikola Tesla Museum and the Nikola Tesla Society (which is apparently named after Tesla, but really is a Jugoslav counterpart of the AIEE). Last night a group of engineers, professors, and other members of the Society gave me a warm reception at the Museum, during which I was made an honorary member and presented with a beautiful diploma certifying to the fact. The Cultural Attaché of the U. S. Embassy was one of the guests. In accepting this honor, I conveyed the good wishes of the AIEE, told of the meeting last October and of the reception of the painting in January (*Electrical Engineering*, April 1957, p. 323). Everyone there seemed deeply impressed.

There is far more material in Tesla's files than I had expected—I believe that about 170,000 items of letters, papers, clippings, and, of course, old bills. I find that practically everything he ever received, Tesla saved. I may be able to arrange to have a microfilm copy of the whole business made and sent to the United States.

Before I started serious work at the Museum, I took a 10-day unescorted trip through Titograd, Kotor, Dubrovich, Mosar, and Sarajevo. Although about all I can say in Serbo-Croatian is "Hello, how are you?" "Where is the toilet?" "Thank you," and "So long!" I had a wonderful, though occasionally adventuresome, time. Everyone seemed to light up when they discovered that I was an American. The kindness and helpfulness of complete strangers was heartwarming.

Sincerely,

/*Signed*/ KEN SWEZEY

NEW BOOKS

The following new books are among those recently received at the Engineering Societies Library. Unless otherwise specified, books listed have been presented by the publishers. The Institute assumes no responsibility for statements made in the following summaries, information for which is taken from the prefaces of the books in question.

ASTM STANDARDS ON COPPER AND COPPER ALLOYS, 1957. Published 1957 by the American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa. 674 pages, 6 by 9 inches, paper. $6.25. A convenient compilation of the methods of test and specifications pertaining to copper and copper-alloy sheet, strip, bar, shapes, wire, pipe, and tube, copper and copper-alloy electrical conductors, copper castings, and nonferrous metals used in copper alloys. Some 130 standards are included of which 34 have been revised since the last compilation in 1955. The standards are grouped in broadly classified sections with a subject index, and also a listing in numerical sequence.

APPLIED PROBABILITY. Proceedings of the Seventh Symposium on Applied Mathematics, 1955. Published 1957 by McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N. Y. 104 pages, 6¾ by 10¼ inches bound. $5. Sponsored by the American Mathematical Society and the Office of Naval Research, this symposium consists of nine papers as follows: Brownian motion depending on n parameters; the first boundary-value problem; boundaries defined by stochastic matrices (abstract); application of functional calculus to the statistical theory of turbulence; stochastic processes of astronomical interest; singularity in the spectrum of homogenous turbulence; probability in classical physics; infinite models in physics; and quantum theory and the foundations of probability.

BIBLIOGRAPHY AND ABSTRACTS ON ELECTRICAL CONTACTS. (1956 Supplement) Published 1957 as Special Technical Publication No. 56-K by The American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa. 40 pages, 6 by 9 inches, paper. $1.75. The current supplement raises to over 2,400 the total number of references in the 1951 cumulation and the subsequent supplements. The references, many including extensive abstracts, are taken from some 250 periodical publications, of which a list is provided.

DANGEROUS PROPERTIES OF INDUSTRIAL MATERIALS. By N. I. Sax. Reinhold Publishing Corporation, 430 Park Ave., New York 22, N. Y., 1957. 1,467 pages, 7 by 10¼ inches, bound. $22.50. Over 8,500 hazardous industrial materials, including trade-name products, are covered in this new edition of the book formerly called "Handbook of Dangerous Materials." Over 1,000 pages are devoted to the alphabetical general chemical section, with nine smaller sections on toxicology, ventilation control, personnel protection and personal hygiene, atmospheric pollution, radiation hazards, industrial fire protection, storage and handling of hazardous materials (explosives, etc.), reactor safeguards, and allergic disease in industry. Detailed information is given on hazardous properties and situations, safety precautions, symptoms and treatments, shipping regulations, and the important characteristics of the individual materials. The encyclopedic arrangement of the volume and an extensive cross-reference system provide ready access to the information.

THE DETECTION AND MEASUREMENT OF INFRARED RADIATION. By R. A. Smith and others. Oxford University Press, 114 Fifth Ave., New York 11, N. Y., 1957. 458 pages, 5¾ by 9 inches, bound. $11.20. The first comprehensive treatment of modern practice in infrared techniques. The coverage is shown by the chapter headings: emission and absorption of radiation, thermal detectors of infrared radiation, photodetectors, limitations to the accuracy of measurement set by random fluctuations, fluctuations in amplifiers and indicating instruments, ultimate sensitivity of detectors, optical components for infrared, infrared spectrometers, atmospheric transmission of infrared radiation.

ESTIMATING GENERAL CONSTRUCTION COSTS. By Louis Dallavia. F. W. Dodge Corporation, 119 W. 40th St., New York 18, N. Y., second edition, 1957. 197 pages, 6 by 9¼ inches, bound. $8.50. A revised edition of a work privately published by the author's company in 1954. The author, a construction estimator by profession, here presents a system that is applicable to a wide variety of job conditions. Based on 160 tables of specific operational costs, the system outlined provides basic cost and production data, which are then modified according to a productivity index derived from 25 project conditions such as labor, equipment, weather, and the general economy.

HANDBOOK OF NOISE CONTROL. Edited by C. M. Harris. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N. Y., 1957. Various pagings, 6½ by 9½ inches, bound. $16.50. Some 40 chapters with accompanying lists of references, provide comprehensive coverage of the nature of noise, its measurement, and techniques of its control in buildings, industry, transportation, and the community. Prepared by 46 experts, the handbook treats vibration isolation, damping, and measurement; acoustical filters and mufflers; special types of noise such as that in bearings, gears, fans, water systems, and electric motors; and physiological, psychological, and legal aspects of noise. Examples from existing installations show application of methods for solving noise control problems.

INDUKTIONSMASCHINEN. By W. Schuisky. Springer-Verlag, Vienna, Austria, 1957. 501 pages, 6½ by 9¾ inches, bound. $21.20. A comprehensive survey of induction motors for the practical engineer, covering present-day design, operation, and applications. Numerical examples are included to provide for effective comparison and relation of computed values with measured values. Among the topics covered are skin effects, starting, mechanical aspects, heating of motors, and special uses.

IONIZATION AND BREAKDOWN IN GASES. By F. Llewellyn-Jones. John Wiley & Sons Inc., 440 Fourth Ave., New York 16, N. Y., 1957. 176 pages, 4¾ by 7½ inches, bound. $3.50. The aim of this monograph is to give a brief account of the fundamental physics of the electric breakdown in gases and to further the understanding of the phenomenon of the electric spark. The book covers the dynamical theory of the motion of charged particles in an ideal gas, the fundamental processes of ionization and de-ionization, breakdown in static uniform fields at various gas pressures including extreme conditions, temporal growth of ionization, and several specialized cases.

NICHTSTATIONARE VORGANGE IN DEN ZULEITUNGS- UND ABLEITUNGSKANALEN VON WASSERKRAFTWERKEN. By Josef Frank. Springer-Verlag, Berlin, Germany, second edition, 1957. 333 pages 6¼ by 9¼ inches, bound. DM 48. A specialized treatment of nonsteady-state phenomena in inlet and diversion channels of hydroelectric plants. The two main sections deal respectively with translation waves in open channels and with surge tanks in pressure conduits.

NOTES ON ANALOG-DIGITAL CONVERSION TECHNIQUES. Edited by A. K. Susskind. The Technology Press, Massachusetts Institute of Technology, Cambridge 39, Mass., 1957. Various paging, 6 by 9 inches, paper $10. Designed for the practicing engineer, this book provides the necessary background for readers who do not have previous experience in the field. It includes an introduction to the theory of sampling, quantizing, and coding; detailed analysis and evaluation of basic coding and decoding methods for electrical and mechanical analog quantities; a case study showing how basic principles were applied in a digital flight-test instrumentation system.

NUCLEAR POWER REACTORS. Edited by J. K. Pickard. D. Van Nostrand Company, Inc., 120 Alexander St., Princeton, N. J., 1957. 388 pages, 6 by 9¼ inches, bound. $8.50. Selected and arranged information from the papers presented at the Geneva Conference. After a discussion of the present outlook for heavy power production from nuclear sources, the book covers basic facts on reactor design and construction and a comparison of various types as power producers. An extensive chapter is devoted to economic considerations, and detailed studies are presented of the different types of reactors.

PASSIVE NETWORK SYNTHESIS. By J. E. Storer. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N. Y., 1957. 319 pages, 6 by 9¼ inches, bound. $8.50. "Network synthesis can be broadly defined as any, and all, methods used in determining an electric circuit meeting certain prescribed specifications." The purpose of this text is to survey the techniques used in synthesizing passive networks containing a finite number of linear lumped elements. The main divisions are as follows: realization methods for impedances; synthesis methods for two terminal pair networks, covering both image parameter and modern insertion loss methods; rational fraction approximations.

PRINCIPLES OF THE PROPERTIES OF MATERIALS. By J. P. Frankel. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N. Y., 1957. 228 pages 6 by 9¼ inches, bound. $6. A study of the properties of materials which utilizes a new approach by emphasizing principles and properties rather than treating materials separately. The properties dealt with in separate chapters are conductivity, heating, diffusivity, electrochemistry, elasticity, plasticity, fracture, viscosity, and general considerations of crystallinity. An introductory section on physicochemical foundations deals with atoms, equilibrium, structure, cohesion, and the electron theory of metals.

ROCKETS, MISSILES, AND SPACE TRAVEL. By Willy Ley. The Viking Press, 625 Madison Ave., New York 22, N. Y., revised edition, 1957. 528 pages, 6 by 8½ inches, bound. $6.75. An account, for the nonspecialist, of the history of rocket and missile development and of the problems of space flight. It covers German war rockets, Project Vanguard, types of rockets and fuels, and rocket airplanes, with a considerable amount of data—characteristics of rockets, records of firings, atmosphere at different distances from the earth, etc.—given in appendixes.

SELECTION AND APPLICATION OF METALLIC RECTIFIERS. By S. P. Jackson. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N. Y., 1957. 326 pages, 6 by 9¼ inches, bound. $8. Characteristic of each of the fundamental types of metallic rectifiers are presented, including ratings, rating methods, and instructions on the use of manufacturers data. Fundamental rectifier circuits, filter circuits, and cell characteristics are also covered, and design procedures shown for such uses as pulse circuits, electroplating power supplies, battery charging, and amplistats. Design data is given in curves and equations form, and there is a short bibliography.

SOLID-STATE PHYSICS, VOLUME IV. Edited by Frederick Seitz and David Turnbull. Academic Press, Inc., 111 Fifth Ave., New York 3, N. Y., 1957. 540 pages, 6¼ by 9¼ inches, bound. $12. The fourth volume of this series of reviews of important advances in solid-state physics contains one paper of 196 pages on ferroelectrics and antiferroelectrics and another of slightly less extent on the theory of mobility of electrons in solids. Three shorter papers are devoted to the orthogonalized plane-wave method, a bibliography of atomic wave functions, and techniques of zone melting and crystal growing.

STRUCTURES GRANULAIRES FERROMAGNÉTIQUES. By P. M. Prache. Dunod, Paris, France, 1957. 76 pages, 8¼ by 11½ inches, paper. Fr.frcs. 1,200. Magnetic mater-

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CORRECTION: The review of "Automatic Digital Calculators" second edition which appeared in the September 1957 issue gave the list price for this book at $60; it should correctly read $6. The publishers have since moved to new quarters and request publication of their new address which is: Academic Press Inc., Publishers, 111 Fifth Ave., New York, N. Y.

ials commonly used in telecommunications practically consist of small-grained, compact granular structures. The first part of the paper shows that for such granular structures a ferromagnetic theory can be set up by considering that the domains are constituted by the grains themselves. Considering the action of high-frequency alternating magnetic fields, the second part deals with phenomena caused by magneto-mechanical couplings in the atom, and the third part with the effects of propagation of electromagnetic waves in the grains.

SYMPOSIUM ON RADIATION EFFECTS ON MATERIALS. ASTM Special Technical Publication No. *208*. Published 1957 by The American Society for Testing Materials (ASTM), 1916 Race St., Philadelphia 3, Pa. 190 pages, 6 by 9¼ inches, bound. $4.75. The first of a series of symposiums on this subject, sponsored jointly by ASTM and the Atomic Industrial Forum. The 16 papers included deal with theory, radiation facilities and mechanics of testing, and with experimental work both on fuel and graphite materials and structural materials. Radiation effects on plastics, organic materials, plain-carbon steels, stainless steel, and copper-iron alloys are discussed.

TECHNICAL LITERATURE

The following recently issued technical literature may be of interest to readers of *Electrical Engineering*. All inquiries should be addressed to the issuers.

BASIC RESEARCH—A NATIONAL RESOURCE. Presenting a strong case for increased support for basic research in the sciences from private as well as public sources, this report released by the National Science Foundation commends for public consideration several far-reaching measures affecting the future of science in the United States. In addition to a statistical and descriptive analysis of the basic research effort of the United States, the report suggests consideration of a number of possible ways to encourage research in science. These include increased support for research at universities which conforms to their educational and scholarly programs with reduction of support for enterprises for which the university is not uniquely fitted; a redefinition of the rules under which tax exemption privileges are now accorded to nonprofit research institutes; changes in Federal income tax laws to stimulate private philanthropic giving for basic research; and a program of Federal grants-in-aid to states designed to increase state financial participation in the support of basic research. The 64-page report is divided into four parts: a brief (7-page) general summary; a section on the rise of basic research with three examples of active and promising research—radio astronomy, virus heredity, and translation by electronics; a section on basic research in the United States which describes the relationship of basic research to interested segments of the economy—educational institutions, industry, and Government; and a final section on strengthening basic research which itemizes positive steps that can be taken to stimulate the progress of basic research. Copies may be purchased for 45¢ from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.

PROJECT VANGUARD REPORT NO. 18, MINITRACK REPORT NO. 1—PHASE MEASUREMENT. A report briefly describing Minitrack, the Naval Research Laboratory (NRL) earth satellite tracking system which has been tracking the Soviet Sputnik, has been released to the public by the U. S. Navy through the Office of Technical Services (OTS), U. S. Department of Commerce. This report, first of a series on Minitrack, gives detailed information on the phase measurement portion of the system. The most basic problem created by a satellite after it is placed on orbit, according to NRL, is proving that the satellite is, in fact, orbiting and measuring its orbit. Minitrack was developed to provide acquisition and tracking by radio techniques. It is a phase-comparison system which receives through eight antennas the signals from the low-power, lightweight transmitter in the satellite. By phase-comparison techniques, it measures the angular position of the satellite as it passes through the antenna beam, recording its "signature" automatically without the need for additional tracking information. Analysis of this signature provides the complete angular history of the satellite passage. The report, *PB 131220*, C. A. Schroeder, C. H. Looney, Jr., and H. E. Carpenter, Jr., Naval Research Laboratory, may be ordered from OTS, U. S. Department of Commerce, Washington 25, D. C., price $1. It contains 31 pages.

PROBLEMS AND PRACTICES IN ENGINEERING MANAGEMENT. Published by the American Management Association, Inc. (AMA), 1515 Broadway, Times Square, New York 36, N. Y. Special Report *24*, 132 pages, $3.75 (AMA members: $2.50). The critical shortage of engineers demands that available engineering manpower be used effectively. Companies must re-examine their current organization of the engineering function, and apply practical new managerial techniques. This special report shows how companies have improved and clarified the functions of the engineering organization (Sylvania Electric Products, Inc., International Business Machines Corporation, Convair, Division of General Dynamics); administered successful engineering programs (Temco Aircraft Corporation, Ford Motor Company, etc.); and organized for efficient systems engineering (Bell Telephone Laboratories, etc.). Other papers discuss the role of top management in the engineering program, timely but neglected methods of easing the engineering shortage, and the commercial development of nuclear power. This report is based on material presented on April 4-5, 1957, at the "Engineering Management Forum," a special conference held by the Research and Development Division of the AMA.

ELECTRONIC CIRCUITRY FOR INSTRUMENTS AND EQUIPMENT. By M. H. Aronson, this series of articles was published by Instruments Publishing Co., 845 Ridge Ave., Pittsburgh 12, Pa. 305 pages. Second edition, 1957. Price $2. The material appearing in this valuable home-study text taken from the magazine *Instruments & Automation*, contains a wealth of pertinent data in nonmathematical, concise style. The text is divided into 15 chapters which cover fundamentals, vacuum tubes, gas-filled tubes, rectification and power supplies, amplifier circuits, solid-state amplifiers, oscillator circuits, signal-shaping circuits, electrical and electronic test equipment, r-f communication and television, scientific and industrial instruments, and military electronics. The book also carries 450 multiple-choice questions in order to enable the student to check his grasp of the subject.

EIA STANDARDS. Two new recommended standards for the electronics industry have been made available to industry by the Electronic Industries Association (EIA—formerly RETMA). The standards were published following approval by representatives of the industry, including members and nonmembers of EIA. Titles of the standards are: *RS-196*—Fixed Film Resistors (High Stability). 60¢ each. This standard from Standards Proposal No. *507* is new material. *RS-197*—Power Inductors for Electronic Equipment. 50¢ each. This standard from Standards Proposals Nos. *511* and *526* is a revision of *TR-110-B*. Copies are available to all segments of the electronics industry and recently were distributed to representatives of all EIA member-companies. Nonmembers of the EIA may obtain copies of the new standards through the EIA Engineering Department, 11 W. 42nd St., New York 36, N. Y. (a minimum charge of $1 is made on all orders).

PUMPED STORAGE FOR HYDROELECTRIC POWER. A Selected List of References in English, copies of this bibliography, covering the years 1928 to September 1957, are available upon request from B. L. Foy, Technical Librarian, Tennessee Valley Authority, Knoxville, Tenn.

1957-58 RCA VICTOR TELEVISION SERVICING INFORMATION. This new manual presents all service information needed to repair properly any of the recently released Radio Corporation of America (RCA) television sets. The manual is priced at $1.50, postpaid. Supreme Publications, 1760 Balsam Road, Highland Park, Ill.

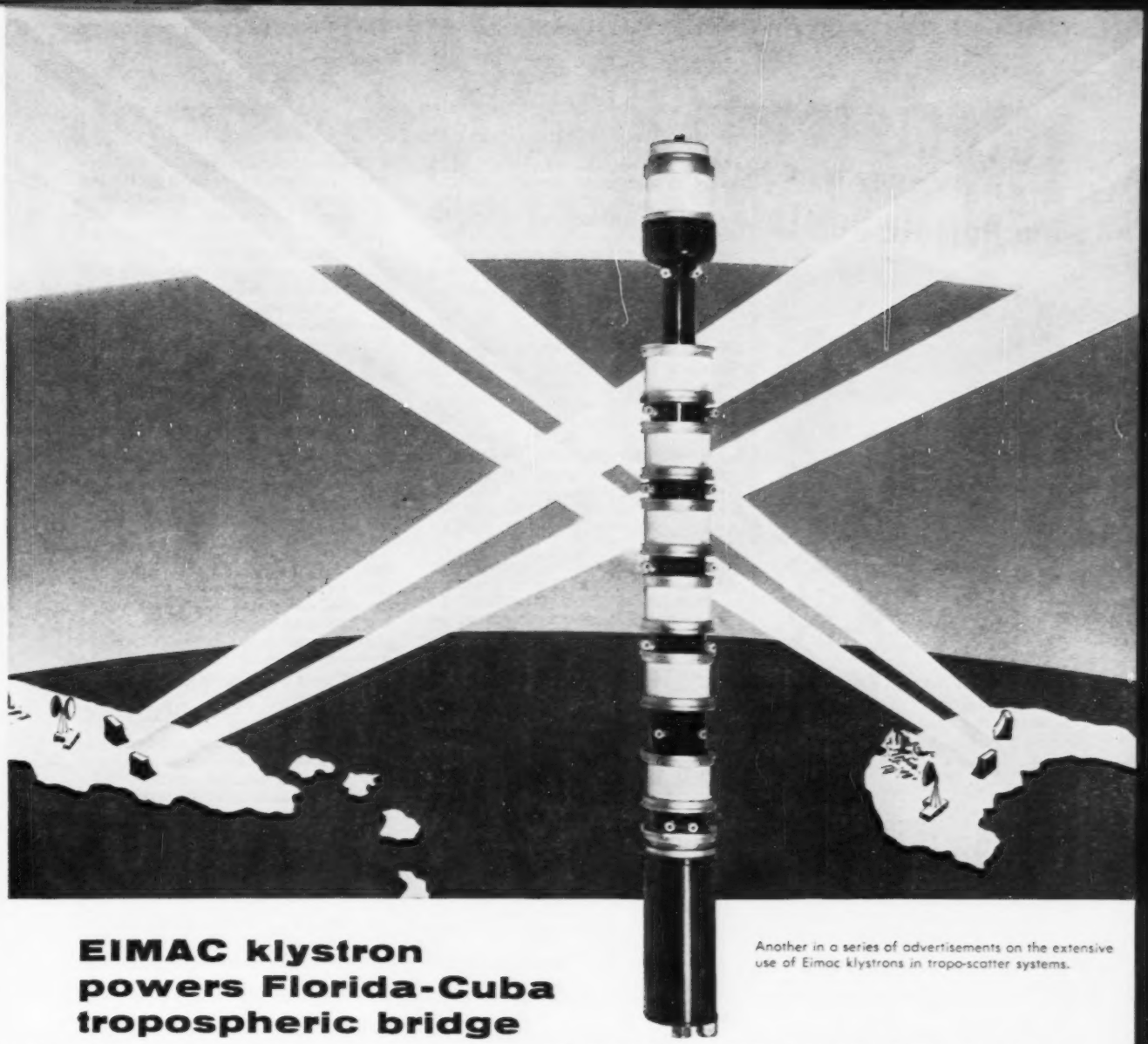
ELECTRIC HYGROMETERS. The National Bureau of Standards Circular *586*, by Arnold Wexler, issued September 3, 1957, 21 pages, 20¢, can be ordered from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. This publication reviews the field of electric hygrometry—determining the moisture content of air (or any gas) by measurement of the electrical resistance of a hygroscopic material with change in humidity. The various humidity sensors are classified and discussed in accordance with their basic principles of operation, that is, their dependence upon the conductivity of aqueous electrolytic solutions, the surface resistivity of impervious solids, the volume resistivity of porous solids, the resistivity of dimensionally variable materials, the temperature of saturated salt solutions, and the electrolysis of water. The simple circuits which are used to measure the resistance of the sensors are also presented. One section discusses the relative advantages and disadvantages of different types of sensors and the concluding section contains a list of further references on electric hygrometry. (Foreign remittance must be in U. S. exchange and should include an additional one-fourth of the publication price to cover mailing costs.)

PROCEEDINGS OF THE 1957 NATIONAL INDUSTRIAL RESEARCH CONFERENCE. This conference was held April 24-25, 1957, in Chicago, Ill., with "Research for Profit" as the theme. The proceedings contain reprints of 12 addresses on sales growth through research, more research for the dollar, and extra dividends from research. Copies may be obtained by sending a $6 check or money order to Mrs. Alice Jones, NIRC-11 at: Armour Research Foundation, Illinois Institute of Technology, 10 W. 35th St., Chicago, Ill.

NEW LESSONS IN ARC WELDING. A second edition of this well-known text, completely rewritten and revised to include new procedures, information on latest machines and electrodes, and modern teaching methods for manual arc welding. The 320 pages are well illustrated with pictures and drawings; price $1.00 postpaid in U.S.A., $1.50 elsewhere. Publisher, The Lincoln Electric Company, Cleveland, Ohio.

HANDBOOK OF POWERED INDUSTRIAL TRUCKS. The most complete and authoritative handbook ever developed on the subject of industrial trucks, has been published by the Industrial Truck Association (ITA), Washington, D. C. The 96-page publication is the result of nearly three years' effort on the part of various ITA committees. It is divided into five convenient sections: industrial truck applications, cost savings through industrial truck handling, planning for and selection of industrial trucks, industrial truck engineering data, and industrial trucks and the future. Designed to answer the needs of purchasing, operating, production, maintenance, and material handling personnel in all industries. It contains dozens of case studies showing specific industrial truck applications, as well as nearly 200 illustrations of types, attachments, containers, and load carrying devices. In addition, numerous engineering tables, graphs and charts are used to present practical truck operating data. Copies of the handbook may be obtained from the Industrial Truck Association, Ninth and F Sts., Washington 4, D. C. Cost, $5 per copy.

THE INDUSTRIAL PH HANDBOOK. This 80-page handbook which is the first manual ever published giving such thorough coverage of industrial pH information under one cover was compiled and edited by T. J. Kehoe, application engineering supervisor. The handbook reviews industrial pH control systems, their principles, application engineering, and equipment, providing a convenient reference source on pH for persons involved in designing, engineering, purchasing, and operating industrial pH systems; and contains approximately 100 illustrations, plus charts, tables, and a bibliography of reference literature on pH measurement. For copies of the handbook, write to Beckman Instruments, Inc., Process Instruments Division, Fullerton, Calif. Price: $2 per copy.



EIMAC klystron powers Florida-Cuba tropospheric bridge

Another in a series of advertisements on the extensive use of Eimac klystrons in tropo-scatter systems.

Federal Telecommunication Laboratories O/H tropospheric equipment built for American Telephone and Telegraph Company and International Telephone and Telegraph Company spans the gap between Florida and Cuba, transmitting TV programs simultaneously with multi-channel telephone service.

Each site of this joint A. T. & T. and I. T. & T. system employs two transmitters and four receivers to obtain space and frequency diversity. Radio equipment has sufficient band width to handle a television program and 120 or more telephone messages.

In the final amplifier of the FTL 12-1 System, engineers specified the Eimac 6K50,000LQ. This six cavity water cooled klystron delivers 10 kw rf output power in FTL equipment with a power gain of 1000 times and band widths to 20 mc.

EITEL-McCULLOUGH, INC.
SAN BRUNO · CALIFORNIA

Eimac First for high-power amplifier klystrons.

Eimac®

6K50,000LQ KLYSTRON AMPLIFIER

Electrical		Mechanical	
Power Output	10 KW CW	Cathode	Bombarded
Frequency Range	720-980 Mc.	Number of Cavities	Six
Gain	Greater than 50 db. (Narrow band)	Overall Length	58"
Beam Voltage	16 KV DC	Outside Diameter	5"
Beam Current	1.62 Amps	RF circuitry including tube	26" diameter x 61" high

Telemeter ANY VARIABLE from Remote Points

Accurate, Fast Acting, Frequency Type Telemeter for Transmission over Wire Lines, Microwave, and Power Line Carrier

Accurate HIGH-SPEED Continuous Telemeter for VOLTS AMPS WATTS VARS ETC.

•

Built-in Self-Calibrating Circuit

•

The Model 1025 Telemeter Transmitter converts DC mv from thermal converters, etc., to 10-30 cps which frequency modulates a built-in audio tone channel. AC 10 to 30 cps or relay outputs are also available. Receiver detects and demodulates transmitted signal, generating a DC mv for operation of recorders or indicating instruments. Up to 45 telemeters can be multiplexed.

Any communication link, including power line carrier, microwave or wire line may be used.

Over-all accuracy is 1% with a response speed of 1 second. Equipment features a built-in calibration circuit for 10% and 90% receiver check, and 10 cps and 30 cps transmitter check.

Any quantity which may be converted into a DC millivoltage or will operate a slidewire may be telemetered.

WE CAN HELP YOU
Our Applications Department is ready to assist you in your control, telemetering or communications problem. Phone DEerfield 4-3100.

Write for Technical and Application Data.

Radio Frequency LABORATORIES, INC.
Boonton, New Jersey, U. S. A.

INDUSTRIAL NOTES

Address Change. Announcement of a change in address of the Augusta, Ga., district sales office of The Babcock & Wilcox Company's Refractories Division has been made. Formerly located at the company's Augusta Works in South Augusta, the office has been moved to Room 408 of the News Building, 725-31 Broad St., Augusta, Ga.

Olin Mathieson in New England. Olin Mathieson Chemical Corporation has announced the opening of a New England sales office for Olin Aluminum at 49 Waltham St., Lexington, Mass. The office will be managed by R. W. Pierce, formerly with the Aluminum Company of America, Bridgeport, Conn. The new sales office will serve Massachusetts, Rhode Island, Maine, New Hampshire, and Vermont.

Office Move. The central regional office of Ebasco Services Incorporated has moved to the Field Building, 140 S. Clark St., Chicago 3, Ill. Ebasco's headquarters are at 2 Rector St., New York, N.Y., and in addition to its central regional office, the company has offices in Dallas, Tex., Portland, Oreg., San Francisco, Calif., and Washington, D. C.

Lenkurt Military Division. Lenkurt Electric Company wishes to announce the establishment of a military division. This division will be engaged in the development and production of communications equipment for the armed forces. It will function as an independent unit with its own purchasing activity, temporarily located at San Carlos, Calif. This purchasing activity will be headed by David Steinberg, procurement manager. Purchase orders, requests for quotation, and correspondence will be clearly identified as military division. In addition, all purchase orders will bear the prefix "M," followed by a four-digit number.

Infrared Teflon Heating. New quartz lamp infrared ovens are achieving exceptional results in the heating or sintering of Teflon. The infrared method is demonstrating its ability to shorten Teflon heating cycles to a matter of seconds, and radiant ovens are being used to process Teflon on cable and other extruded items with great success. Small electrical items wrapped with Teflon can also be sintered effectively. Additional data on quartz lamp infrared ovens is available from The Fostoria Pressed Steel Corporation, 1950 Bradner St., Fostoria, Ohio.

Important Radar Patent. A patent for one of the most significant military and commercial radar developments has been granted to International Telephone and Telegraph Corporation (IT&T), 67 Broad St., New York 4, N.Y., on an invention of P. F. M. Gloess, a French scientist formerly with IT&T's Paris, France, laboratories. The patent covers the practical form of radar generally used today on ships, airplanes, and for defense purposes. It is known as plan position indicator (PPI) radar. Whereas radar in its original form enables one to pick out and measure the distance to unknown objects individually, the patented system as proposed and now highly developed gives a direct indication of the distance and angular position, relative to the viewer, of all objects within a wide angle simultaneously. Thus, the disposition of an entire fleet of ships, or the positions of all airplanes waiting to land at an airport, are shown on the face of a cathode-ray tube as if on a map, and their exact position can be directly read from the distance and angular scales on the tube. The invention similarly will show the contour of land ahead of and below an airplane, will draw a picture of the coastline for a ship approaching at night or in fog, or will reveal the position of attacking aircraft or missiles.

Ohio River Power Plant. Construction plans for a major electric power plant on the Ohio River have been announced by The Cleveland Electric Illuminating Company, 75 Public Square, Cleveland 1, Ohio. The plant will be at Rayland, Ohio, adjacent to large coal deposits and served by river transportation.

New Name and Address. The name of Applied Research, Inc., industrial research firm, has been changed to Booz, Allen Applied Research, Inc. The firm's headquarters has been moved to 430 Green Bay Road, Kenilworth, Ill., from 135 S. La Salle St., Chicago, Ill. The firm does research and development work on scientific and technical problems for industrial companies and the government. It was organized in 1955 as an independent corporation by the partners of Booz, Allen & Hamilton, national management consulting firm.

Vacuum Casting. Large commercial castings are now being produced at United States Steel's Duquesne Works, Duquesne, Pa., by a vacuum casting method. Preliminary tests indicate that these castings, which are processed into huge turbine and generator shafts, are superior in quality to those produced by conventional methods. This method of casting extracts harmful gases from the molten metal prior to the formation of the ingot. This in turn is expected to increase ductility in the forgings and to remove their sensitivity to internal ruptures.

Facilities Expansion. Nylok-Detroit Corp., manufacturers of self-sealing, locking, and adjusting threaded parts, announce completion of a facilities expansion program which includes the occupation of new office headquarters in the Jaikins Building, 1100 N. Woodward Ave., Birmingham, Mich., and the acquisition of a new manufacturing plant located at 1893 Barrett Rd., Troy, Mich.

(Continued on page 27A)

Regulate and control electric power

for any manufacturing process

better, accurately, efficiently, with

Sorgel saturable reactors

The control can be a small, manually operated, stepless adjusting auto transformer which can be placed in any desirable location, or it can be automatic.

Available in ratings of 1 Kva to 1000 Kva single phase. 3 to 3000 Kva poly-phase. All voltages up to 15,000 volts.

Sorgel reactors are designed to meet your exact requirements. Let us know what your problems and requirements are, and we will submit our recommendations with complete information.

●

Also a complete line of dry-type transformers

¼ Kva to 2500 Kva single phase.
1 Kva to 3000 Kva poly-phase.
All voltages up to 15,000 volts.

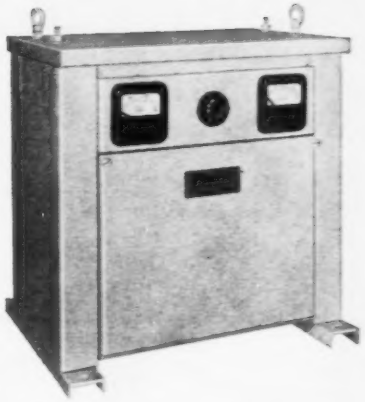
●

Substations

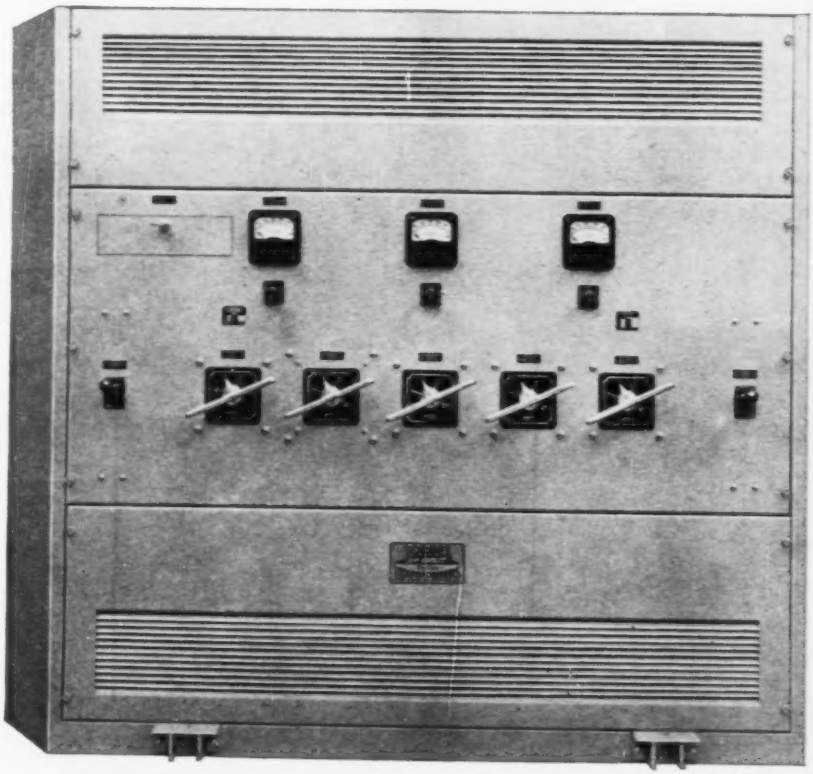
Sorgel transformers, either dry-type or Askarel-cooled, are incorporated in substations, complete with primary or secondary switchgear. They are procurable with any type or make of switchgear, and from any substation manufacturer.

Some typical applications:

Electric furnaces.
Electric heat treating equipment.
Glass melting equipment.
Metal melting equipment.
Electric ovens.
Dimmers for incandescent and infra-red lamps.
Variable speed motors.



15 Kva, single phase, 60 cycle Saturable Reactor with voltmeter, ammeter, D.C. supply and manual control.



470 Kva, three phase, saturable reactor — Transformer combination with circuit breakers and metering. Tap switches on transformer and reactor provide controlled load voltage in six ranges.

SORGEL ELECTRIC CO., 846 West National Ave., Milwaukee 4, Wisconsin

GROUNDS IN GENERATOR FIELD WINDINGS ARE BLUE-CHIP RISKS

New DGF d-c relay provides sensitive ground fault detection - - assuring service continuity.

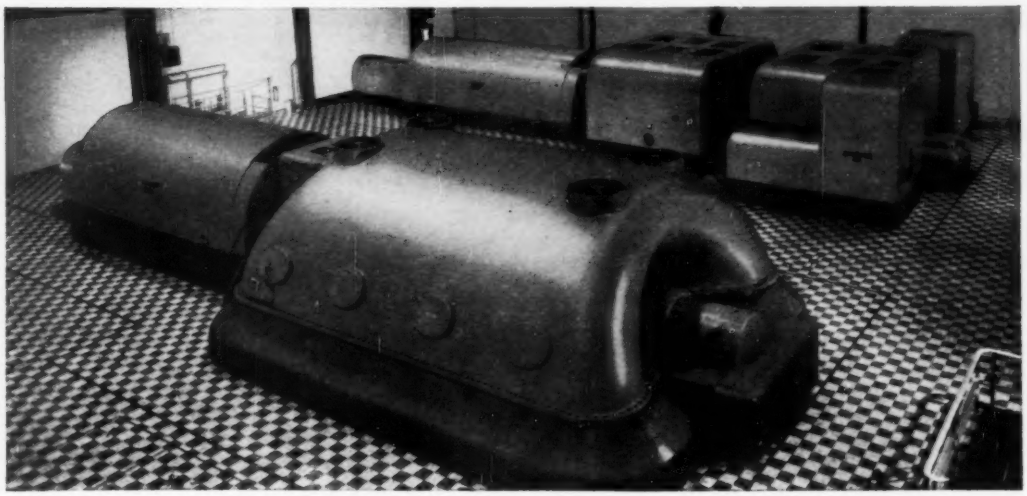
There are no small risks when you play for big stakes. Modern generating units are well up into the blue-chip class—and risking operation with a ground in field windings is not penny-ante.

In itself, such a fault is not serious—will not affect the output of the machine. But a second ground—resulting from the same insulation or mechanical weakness — is full-scale trouble.

Such is the reason for development of the new DGF relay by Westinghouse engineers. Utilizing a sensitive d-c galvanometer-type unit, the DGF is connected through one constant and one non-linear resistor, forming a voltage-divider bridge. There is no more reliable scheme for overall protection.

With your dollar investment—and load conditions which will not tolerate long service outages, we believe you'll welcome discussion of the DGF with your Westinghouse relay specialist. You need only to call your nearby Westinghouse sales office—or write Westinghouse Electric Corp., Box 868, Pittsburgh, Pa.

J-40498



Westinghouse DGF - - Generator Field Protection

YOU CAN BE SURE... IF IT'S Westinghouse

BELL TELEPHONE LABORATORIES DEVELOPS NEW COMPACT COMPUTER FOR U. S. AIR FORCE

J. A. Githens, B.S. in E.E., Drexel Institute of Technology, and J. A. Baird, Ph.D. in E.E., Texas A. & M., check the control panel of Leprechaun, a new high-speed computer which solves extremely complex problems in one-tenth of a second. Small size and low power are made possible by new design principles and Bell Laboratories' invention of the transistor.

The United States Air Force assigned Bell Labs an interesting assignment: develop a new kind of electronic computer. The major requirement was greater simplicity. Of course, no computer is simple, but this one (known as "Leprechaun" to its designers) is much smaller and simpler than most of the computers currently in use.

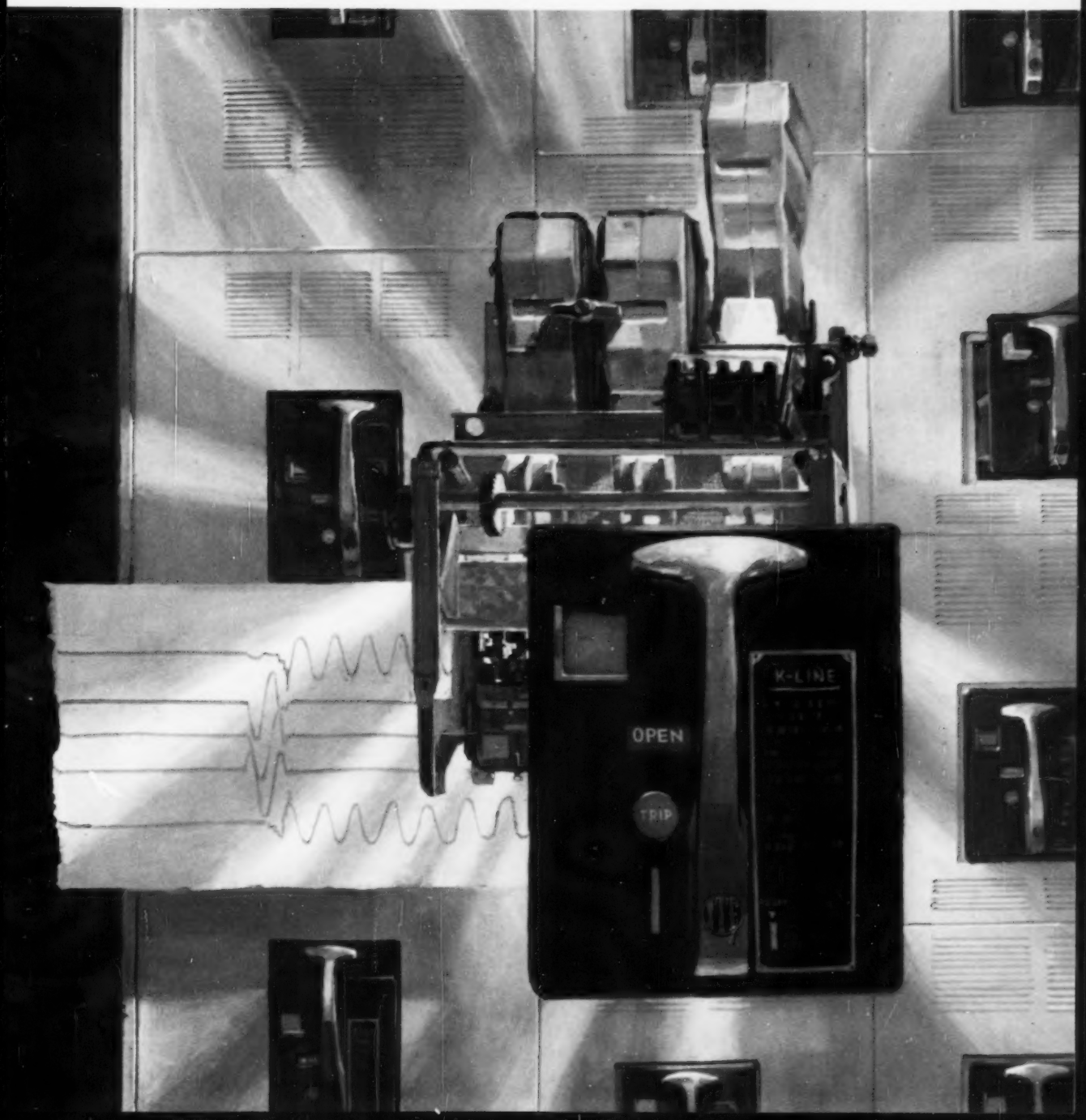
It has only some 9000 electrical components; 5000 of them are transistors. As a result, Leprechaun has less than one-third the components of conventional computers. This facilitates testing, experimentation, assembly and service.

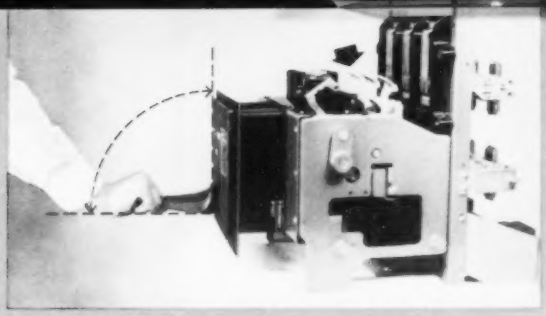
Even in its experimental state, Leprechaun is a stimulating example of great strides in the simplification and miniaturization of circuitry . . . a problem of profound interest to all Bell Laboratories researchers as they develop radically new equipment for your future telephone service.

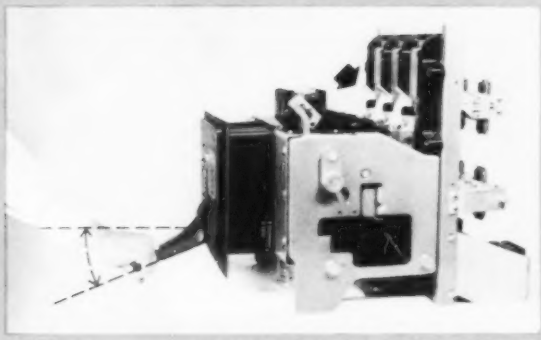
BELL TELEPHONE LABORATORIES

WORLD CENTER OF COMMUNICATIONS RESEARCH AND DEVELOPMENT

I-T-E new K-Line of low voltage switchgear represents the first major advance in this type of equipment in 13 years. This completely new design offers greatly increased safety and operating efficiency, is available in three frame size ratings: 225, 600 and 1600 amp continuous at 600 v alternating current.







Quick-make closure of contacts on manually operated circuit breakers is provided by spring action. The first 90% of the pulldown handle travel loads the springs, the last 10% releases the stored energy and closes the contacts. No teasing is possible.

I-T-E announces sweeping design advances in new line of low voltage power circuit breakers and switchgear

- First quick-make closure of contacts
- First closed-door racking of circuit breakers to any position
- First expanded range overcurrent trip device
- 4-high stacking of 600 amp frame size circuit breakers
- Subassembly construction of circuit breakers & accessories

Quick-make manual closure eliminates damaging arcing, greatly increases life of contacts and circuit breaker—contacts cannot be teased together, breaker cannot be destroyed by careless closing against a major fault.

Quick-make closure, formerly available only on electrically operated circuit breakers, now is a standard feature of all manually operated breakers in the new I-T-E K-Line.

A manually charged stored energy mechanism, powerful enough to close the contacts safely against a full short circuit, provides the manual quick-make action. The first 90% of travel of the new pulldown handle charges a set of springs, the last 10% of travel releases the stored energy and closes the contacts—breaker life and operator safety do not depend on the brawn and brain of the operator. Contacts cannot be teased together, the closing action is fast and positive.

Electrically operated models in the K-Line have an actuating motor in addition to the basic mechanism. This motor-driven, stored energy system requires only 10 amp from a simple power source, compared to as much as 160 amp by comparable solenoid mechanisms. Energy for closing is prestored by the new K-Line circuit breakers in 2 seconds. Closing time is 5 cycles.

Closed-door drawout keeps circuit breakers clean and aisles uncluttered, promotes operator safety

This exclusive I-T-E feature permits racking of breaker into connected, test and disconnected positions without opening the door of the breaker compartment. It facilitates inspection, testing and maintenance. Blocked circuits are easy to identify. It keeps circuit breakers clean even in dust and dirt-laden atmospheres. It keeps aisles uncluttered and clear of compartment doors. It promotes personnel safety.

A lift shutter, which permits insertion of the racking crank that moves the breaker, can be padlocked in connected, test or disconnected position to guarantee complete safety. This shutter cannot be lifted while the circuit breaker is closed. Interlocking also prevents closing of the breaker while the shutter is lifted.

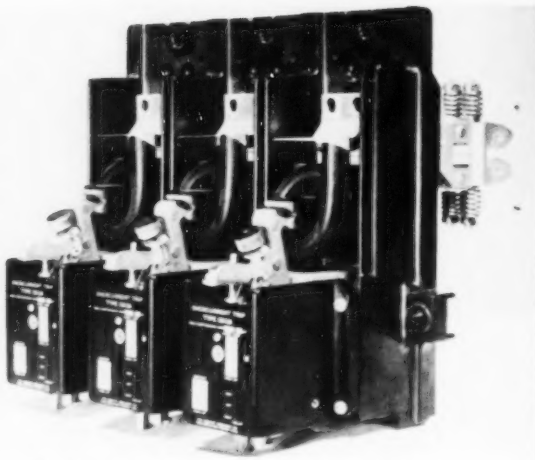
The extendible escutcheon slides through the compartment door while a dust seal surrounding the escutcheon is held in place by the door.

In addition to affording closed-door drawout, the new K-Line of switchgear is smaller than any comparable design. The reduced size of the circuit breakers permits 4-high stacking of 600 amp breakers. And unitized construction reduces the switchgear to three basic components —the breaker, the enclosure, and a cradle on which the circuit breaker rolls for drawout.

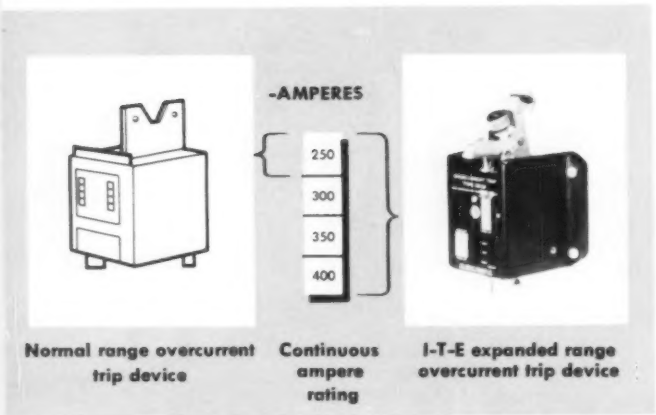
Exclusive closed-door drawout is illustrated in this series of photographs. Photo 1 shows shutter lifted and racking crank inserted. Photo 2 shows circuit breaker in connected position. Photo 3 shows breaker in test position. Photo 4 shows breaker in disconnected position.

New overcurrent trip arrangement permits use of each trip over wider range of continuous load conditions

Accessible trips, on both manual and electrical types, provide new ease of adjustment. Adjustment, a difficult job at best on previous electrical types, can now be made in a matter of seconds.



Common molding holds all three trips for this 600 amp K-Line circuit breaker. Can be replaced in a fraction of time required for changing the individual trips on comparable lines.



This table indicates a sample grouping of ratings for the new K-Line circuit breakers. Only 9 trip units now cover the range of continuous current ratings as against 23 formerly required.

Trip flexibility is an important feature of the K-Line. Only 9 trip units now cover the complete range of continuous current ratings—15 to 1600 amp—as against 23 formerly required. Last-minute changes in load capacity can be satisfied in many instances with the existing trip unit as a result of the expanded range of trip settings.

This feature, plus easy adjustment of trip devices and quick change in the field, is particularly significant in meeting constantly expanding load requirements. Trip units are mounted on a one-piece base. Trip units are changed from the rear and in a fraction of the time formerly required.

For the complete story of the I-T-E K-Line of circuit breakers and switchgear, see your local I-T-E representative. Or write us for Bulletin 6004C. I-T-E CIRCUIT BREAKER COMPANY, Switchgear Division, 19th & Hamilton Sts., Philadelphia 30, Pa.

I-T-E CIRCUIT BREAKER COMPANY

19TH AND HAMILTON STREETS, PHILADELPHIA 30, PENNSYLVANIA

COMMUNICATIONS --
Half the Battle!

Will today's communications help win tomorrow's battles? For a good answer, take a look at how the U. S. Army Signal Corps is keeping ahead of the fast-changing techniques of military operations — by providing *tomorrow's* communications systems *today*.

Look, for example, at the Signal Corps' completely miniaturized, all-transistor carrier system for cable or microwave communication in the field. It is fully portable, takes up less than a cubic foot of space, weighs only 65 pounds (compared to 500 for comparable World War II equipment). It provides 4 separate channels, offers highly reliable operation under severe conditions ranging from Arctic cold to tropic sun.

Lenkurt was selected as prime contractor for the development of this carrier because of its capacity and experience as a *specialist* in telecommunications systems for public and private use. The answer to your most complex communications problem may be found in Lenkurt's unique facilities for research, development and precision production of carrier and microwave.

Lenkurt
ELECTRIC
San Carlos, Calif. • Mexico, D.F. • Vancouver, B.C.

Lenkurt products are distributed to public utilities by AUTOMATIC ELECTRIC

Industrial Notes

(Continued from page 18A)

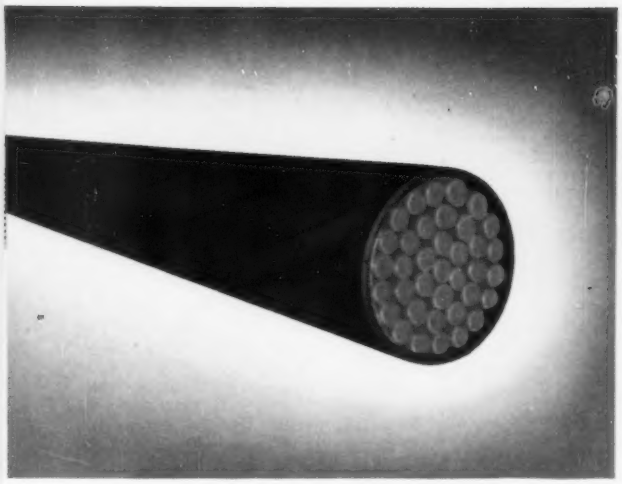
New Organzation. HOLEX Incorporated, P.O. Box 148, Hollister, Calif., is a new engineering and production organization entering the field of explosive ordnance and related devices. Located on a 28-acre site, this company is providing design, development, manufacturing, and test services in the field of packaged explosive power devices and related electronic equipment. Products include igniters for solid- and liquid-rocket engines, pressure cartridges, explosive trains, electrically operated initiators, and thread-in type glass-to-metal seals.

Square D Atlanta Plant. Square D Company, 6060 Rivard St., Detroit 11, Mich., has announced completion of an electrical equipment assembly plant in Atlanta, Ga., the eighth such facility to be constructed by the firm in strategic United States marketing centers since 1951. The newest unit will follow an operating pattern established in earlier assembly plants of incorporating electrical elements mass-produced in the company's major manufacturing installations in Detroit, Mich.; Milwaukee, Wis.; Cleveland, Ohio; and Los Angeles, Calif.; into combinations that meet local customer requirements.

Electrical Insulation Tubing. Heat resistant silicone is one of the chief features of a new electrical insulation tubing, Ben-Har silicone varnish tubing. Made from braided filament glass fibers, with a patented antifray treatment, the tubing is impregnated and completely coated with unmodified silicone varnish. It offers unusual flexibility and can be bent to twice its diameter without cracking the coating. Ben-Har silicone varnish tubing easily meets the revised *MIL-I-3190B* specifications and all Class H requirements. It is available in standard National Electrical Manufacturers Association sizes; in black and nine colors. The smaller sizes have found ready wire harnesses. By combining inorganic materials, Ben-Har silicone varnish tubing is highly resistant to heat, most organic solvents, and offers excellent oil and fungus resistance. Additional data and samples may be had from Bentley, Harris Manufacturing Company, 1002 Bentley St., Conshohocken, Pa.

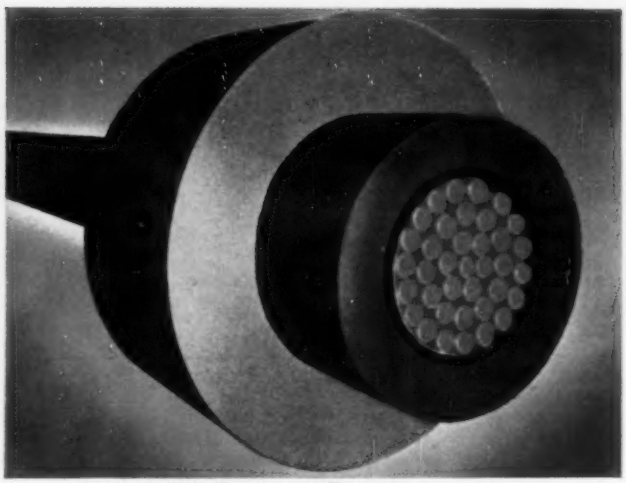
Beckman Instruments. Reorganization of the Shockley Semiconductor Laboratory of Beckman Instruments, Inc., has been announced by Dr. A. O. Beckman, president, who stated that the successful development by Dr. William Shockley, director of the laboratory, and his associates of techniques for commercial production of the new four-layer switching diode calls for the realignment of personnel and duties to provide for increased production as well as for continuing research. M. C. Hanafin, formerly of the Beckman Spinco Division, 589 O'Neill Ave., Belmont, Calif., has been named manager of the Shockley Semiconductor Laboratory located at Palo Alto and Mountain View, Calif.

How the Nepco Process makes Butyl better



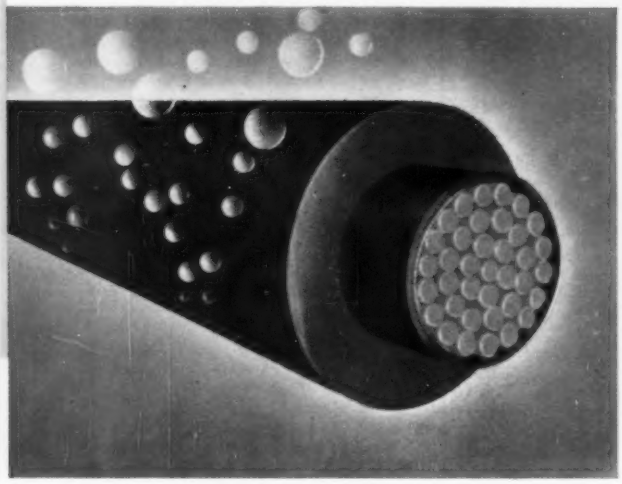
1. Vacuum Chamber Core Cleaning

All cores or copper stranding which in high voltage applications is normally wrapped in a special semi-conducting impregnated tape is passed through a high vacuum chamber to "boil-off" absorbed gases and moisture from the core.



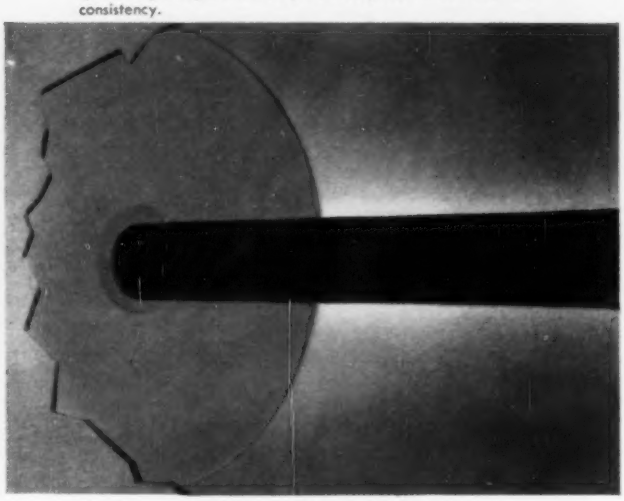
2. Specially Designed Extruders

After investigation, NE selected extrusion as the best method of applying a reliable dense, uniform insulation without troublesome interfaces. Since standard extruders were erratic in their capacity to process Butyl rubber, NE installed new equipment specifically designed to slowly work Butyl rubber at its optimum consistency.



5. Fugitive Vulcanizing Agents

Vulcanizing agents that leave the by-products of the vulcanizing action in the insulation reduce cable service life and electrical stability. NE has developed fugitive vulcanizing agents with volatile decomposition by-products that can be eliminated from the cable construction.



6. Pressure Vessel Vulcanization

NE Butyl is continuously vulcanized at over 400 degrees in a specially designed 200 foot pressure vessel . . . long enough to permit thorough saturation of the reactive centers and to allow the Butyl to interbond with the semi-conducting strand shielding tape to form a continuous mass.

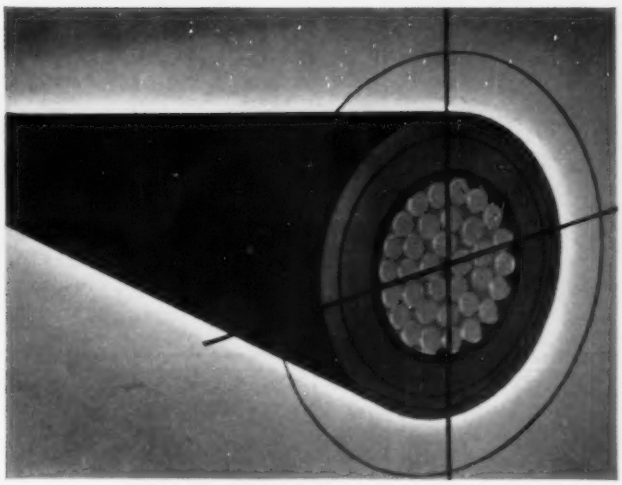
don't say any wire

Butyl rubber has inherent characteristics that make it an ideal insulating material for high temperature, high voltage wire and cable. It has outstanding resistance to heat, ozone and moisture.

To take full advantage of these characteristics requires special know-how and special equipment on the part of the wire and cable manufacturer. Here are eight things which National Electric does to get the best out of Butyl rubber and make NE Butyl insulated wire and cable the most dependable on the market.

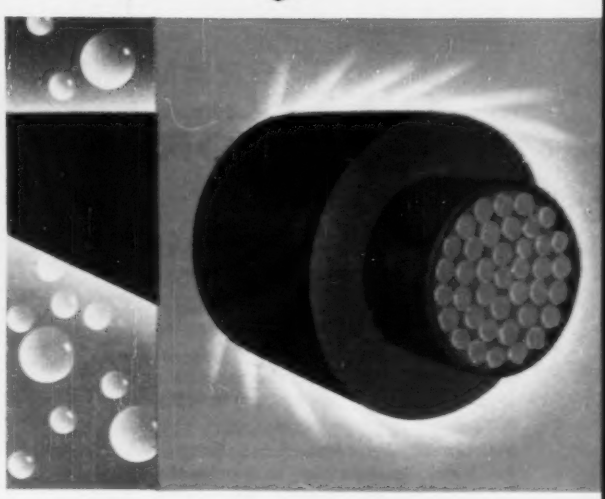
National Electric Products

Pittsburgh, Pa.: 2 Plants • 12 Warehouses • 41 Sales Offices



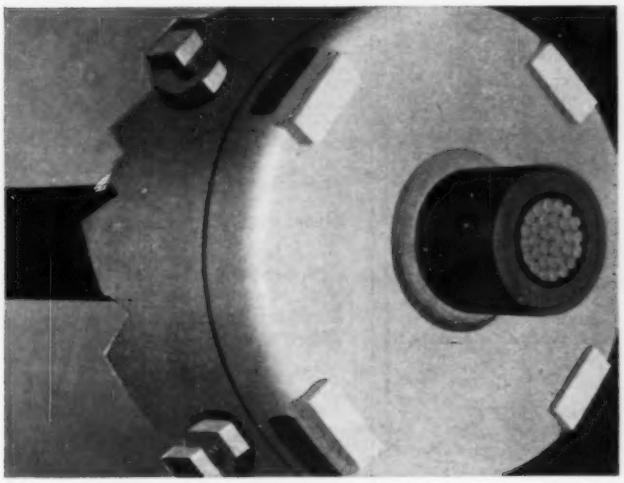
3. Controlled Concentricity

Every foot of cable is checked by a special monitoring station to maintain a perfectly centered core and uniform wall thickness before the material enters the vulcanizing chamber.



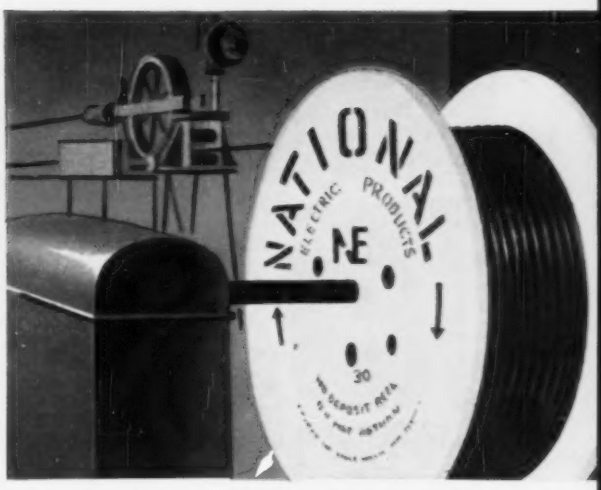
4. Water Cushion Processing

NE Butyl Rubber rides into the vulcanizing chamber through a high pressure water seal that molds the rubber uniformly onto the cable, impregnates the interstices of the shielding tape before vulcanization.



7. Pressure Vessel Cooling

Perhaps the most important part of the Nepco process. NE Butyl insulated cable is slowly cooled in a second pressure vessel under the same pressure at which it was vulcanized. This cooling under high pressure forces gaseous by-products out of the insulation . . . permits the use of volatile vulcanizing agents which leave no harmful residuals behind.

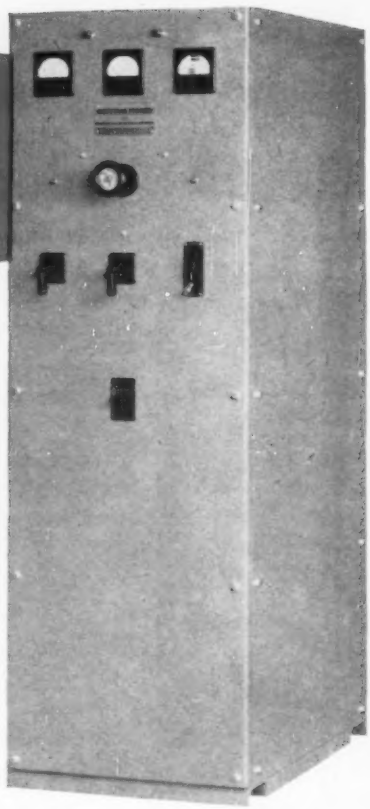


The inherent inertness of the Butyl rubber polymer permits the insulation to be compounded and vulcanized to a much tougher and mechanically stronger material.

A typical National Electric Butyl formulation has at least twice the tensile strength specified for an oil base insulation and will maintain this margin of superiority during long term accelerated service tests. That's why when you plan to install Butyl rubber insulated wire and cable . . . don't say *any* wire . . . say NE Wire.

. . . say NE wire

New CAB
New ECONOMY
New VERSATILITY

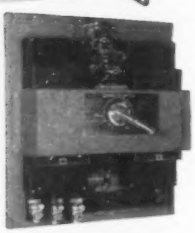


DIESEL GENERATOR *Control*

This new compact floor mount generator control cabinet occupies only 5 sq. ft., and is designed for both single generator standby service and multiple set parallel operation. It is available for ratings to 250 KW, 480 V.

Instrumentation employing large-full-view meters is conveniently located at eye level. Standard parts including molded case circuit breaker, voltage regulator, and transformers assure dependable operation plus servicing convenience.

Specify current requirements for cost-saving details.



TOP MOUNT

Engine-mounted controls for requirements to 150 KW, 480 volts . . . Single and dual voltage service, A.C. or D.C. Also wall-mounted controls to 75 KW, 220/480 V. Standardized components and circuitry for dependable operation and service convenience.

TRANS-O-MATIC

Automatic switch transfers to emergency on failure of normal source. Mechanically linked circuit breakers assure positive transfer . . . with no neutral position possible. Complete relay protection.

ENGINE START CABINET

Single and 5-shot interrupted crank controls for dependable engine starting. Complete cut-out and alarm protection for over-crank, over-speed, low-oil, and water-temperature. Four-position operation "automatic", "test", "manual" and "off"

Request Bulletins For Detail

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FEEDBACK CONTROL SYSTEMS CONFERENCE

The second Feedback Control Systems Conference was held April 21-23, 1954 at Atlantic City, N. J. The papers, as prepared by their respective authors are included in publication S-63. The technical papers and scheduled demonstrations covered the following fields and subjects:

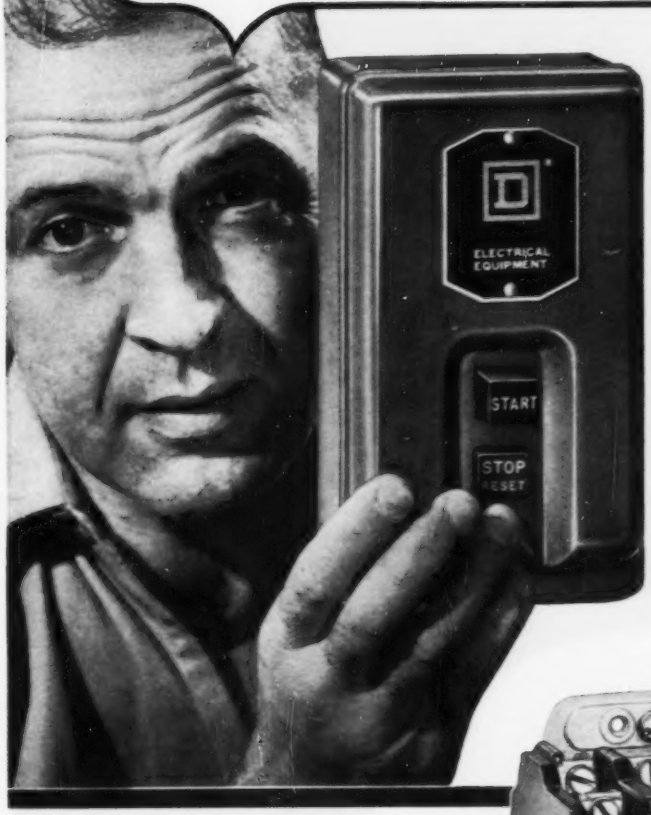
Industrial regulators
Tracer machine tools
Process control
Nucleonics
Aircraft engines
Flight path control
Fire control
Platform stabilization
Flight simulators
Computers
Test equipment
Magnetic Amplifiers
Potentiometers
Gears and dampers

The preceding list indicates a wide range of applications of feedback control as well as the diversity of components.

This 158-page publication, S-63, is available at the price of $3.50 to members and non-members from the Order Department

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS
33 West 39th Street
New York 18, N. Y.

This NEW Manual Starter has EVERYTHING!



NEMA Sizes 0 and 1

Two, three and four-pole construction

SMALLER! Takes less space, whether it's built into machine or mounted externally

SMART STYLING! Matches the streamlined appearance of today's modern machines

QWIK-MAKE, QWIK-BREAK! Positive snap-action opening and closing of contacts. Longer contact life

TRIP-FREE OVERLOAD PROTECTION! Impossible for operator to hold motor circuit closed against overload

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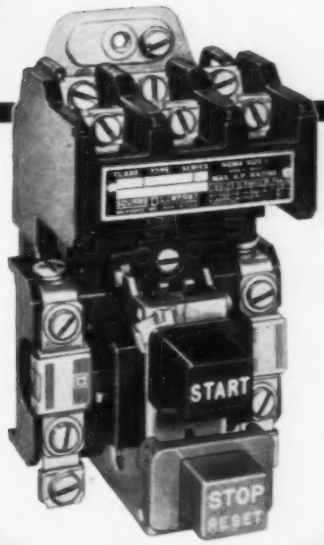
EASIER INSTALLATION! Wire it without removing starter from enclosure. All terminals have pressure wire connectors



EASIER MAINTENANCE!
"Off-the-Shelf" parts kits make normal maintenance and modifications easier than ever. They're easy to buy, easy to identify, and faster to install

TAMPER-PROOF!
Cover padlocking device prevents tampering by unauthorized personnel. Safety latch locks "start" button in "OFF" position

VISIBLE INDICATION OF OVERLOAD!
Self-centering push-buttons show when overload has occurred

CHOICE OF ENCLOSURES:

Water and Dust-Tight
Hazardous Locations
Flush Mounting

Write **for BULLETIN 2510 B-C**
Address Square D Company, 4041 North Richards Street, Milwaukee 12, Wisconsin

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SQUARE D COMPANY

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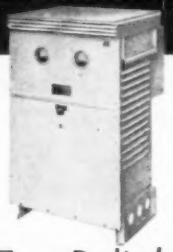
SILICON
POWER RECTIFIERS



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210 TAAFFE PLACE, BROOKLYN 5, N. Y.

NEW PRODUCTS

Missile Weighing System. A digital weighing system has been developed by Performance Measurements Co., for determining center of gravity of missiles and similar objects. The system employs two load cells feeding into a digital reading weight indicator. The two load cells contain strain gauge pickups. They are mounted on the two hooks or saddles used to support the missile. Input of the digital indicator is alternately switched between the two load cells. Readings are then quickly formalized to determine the center of gravity point. Accuracy of the system is said to be 0.1%. Digital indication is enabled through a continuous balance electronic potentiometer. A servo motor drives the precision number wheels. Literature is available from Performance Measurements Company, 15301 W. McNicholas Rd., Detroit 35, Mich.

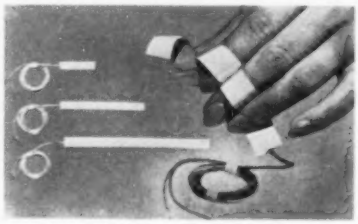
Self-Extinguishing Wiring Raceway. This new channel is completely self-extinguishing. Made of a tough reinforced phenolic, this "panel channel" will under no circumstances support combustion. If subjected to direct flame, it is immediately self-extinguishing without afterglow when the flame is removed. All sizes and styles of panel channel raceway now being manufactured and shipped are utilizing the new material. Complete information is provided in Bulletin No. *S-302* available from Stahlin Brothers, Inc., 310 Maple St., Belding, Mich.

Lithoflo Processor. A revolutionary graphic arts device that automatically develops, fixes, and washes lithographic-size, cut-sheet film and negative papers has been announced by The Haloid Company, 2-20 Haloid St., Rochester, N. Y. The new machine, called the Lithoflo Processor is said to fill the need of large printing houses and lithographic plants for an automatic unit capable of offering extraordinary quality, uniformity, and control in the developing of graphic arts film. For further information contact the company.

Nuclear Monitoring System. The *RAMS-II* (remote area monitoring system) model for detecting nuclear radiation is offered by Jordon Electronics Company. The new model is said to offer many advancements over previous systems of thi type. A new a-c operated power supply eliminates all batteries, and will accommodate up to 20 remote monitoring units. There are 32 different types of standard plug-in monitoring stations to satisfy all requirements, with ranges of 3 or 6 decades from 0.01 milliroentgen per hour and up, and indicating or nonindicating meter relays for operating external alarm or control devices. The control panel contains a 4½-inch panel meter which can be switched to any channel and permits economical station units with no individual meter, if desired. The logarithmic response of the monitoring chamber provides accuracy of ±20% of true dose rate at any point on the scale. Remotely operated calibration sources are available to increase accuracy and to permit operational check at any time. Distance between the monitoring point and the control unit can be 50 feet to 1 mile or more. Recorder terminals are included for each channel. For additional information, contact Jordan Electronics Company, 3025 W. Mission Rd., Alhambra, Calif.

Molded Potential Transformer. A molded potential transformer (Type *EMP*) is now available for use with the polyester molded Type *EMR* and *EMO* current transformers. Molded in polyester, the new transformer is for metering applications, either indoor or outdoor. Voltage rating is 480-120 volts, 60 cycles. It has a thermal capacity of 150 volt-amperes and will operate within the 0.3 ASA accuracy class on practically all single-meter installations. Multimeter installations can be handled with the same accuracy classification if the over-all burden does not exceed 12.5 volt-amperes at 10% power factor. For further information, write Westinghouse Electric Corporation, P. O. Box 2099, Pittsburgh 30, Pa.

Thermal Ribbon. The thermal ribbon provides a means of electrically detecting the temperature of the surface to which it is attached. Extremely flexible and with negligible thermal lag, these thermal ribbons are ideally suited for use in aircraft,



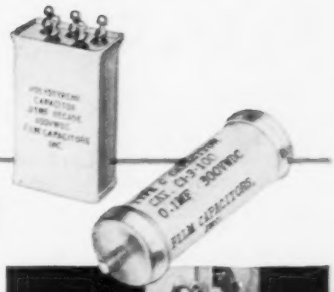
missiles, electronic equipment, and other applications where it is necessary to monitor accurately or to control temperatures of surface areas. Designed to operate over wide temperature ranges, at high altitudes, and under severe physical conditions, thermal ribbons are manufactured in several shapes and sizes by Minco Products, Inc., 740 Washington Ave. N., Minneapolis 1, Minn.

Alternate Pulse Relay. A single coil latching relay that selects alternate circuits or alternate circuit modes on successive impulses has been developed recently. Designated the *PC*, the relay employs an armature driven rocker type actuator to transfer 1, 2, 3, or 4 double-pole, double-throw snap switches. This new relay was developed by the Applications Laboratory, Potter & Brumfield, Inc., a subsidiary of the American Machine & Foundry Company, Princeton, Ind.

(Continued on page 36A)

for + HIGH INSULATION RESISTANCE and CAPACITANCE STABILITY

LOW POWER FACTOR and SOAKAGE



f-c-i Polystyrene Capacitors

are wound with

NATVAR Styroflex®

f-c-i polystyrene capacitors are available in hermetically sealed glass tubes, metal shells, bathtub cases, or metal cans. Operators like Styroflex because it winds easily, and testers find a minimum of rejects.

Film Capacitors, Inc., New York, manufactures capacitors for critical AC and DC circuitry applications—such as bridge arm elements, filter network components, standards of capacitance, RF tank circuits, storage circuits and computer circuits—where stability and high Q are essential.

Natvar Styroflex film is used as the dielectric in f-c-i polystyrene capacitors because of its uniformly high shock resistance and excellent dielectric properties. Because of its bi-axial orientation during the manufacturing process, it is completely flexible in all thicknesses, and easy to handle.

If you need an insulating material with the desirable characteristics of polystyrene—plus pliability, it will pay you to investigate Natvar Styroflex.

Natvar

Natvar Products

- Varnished cambric—cloth and tape
- Varnished canvas and duck
- Varnished silk and special rayon
- Varnished—Silicone coated Fiberglas
- Varnished papers—rope and kraft
- Slot cell combinations—Aboglas®
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- Vinyl coated cambric tubing and sleeving
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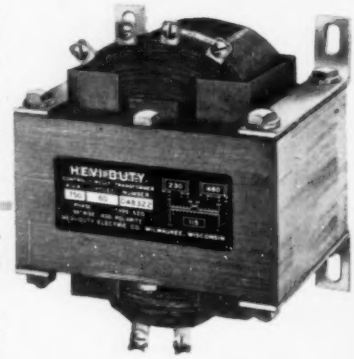
Here's Transformer Progress

You can now obtain 2½ times greater inrush capacity from a *modern* control circuit transformer than you could get just a few years ago. Compare, for example, the inrush current that equally rated units can handle at not more than 5 percent drop below rated voltage.



1940 Ordinary transformer with non-interleaved windings — 400 Percent Inrush.

1945 Type SIO developed by Hevi-Duty with interleaved windings — 700 Percent Inrush

1957 New Type SZO with interleaved windings, plus other new design features developed by Hevi-Duty — 1,000 Percent Inrush

Yes, the story of transformer progress is still being written by Hevi-Duty.

Write for Bulletin 300 for full information on new Type SZO. Capacities from .050 to 5 KVA.

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HEAT TREATING FURNACES HEVI-DUTY ELECTRIC EXCLUSIVELY

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Review of Input and Output Equipment Used in Computing Systems

(March 1953)

The Joint AIEE-IRE-ACM Computer Conference took place on December 10-12, 1952, in New York, N. Y., to discuss the characteristics and performance of input-output equipment as it applies to large-scale electronic digital computers. The conference was held under the direction of the Joint Committee appointed by the Committee on Computing Devices of the American Institute of Electrical Engineers, the Electronic Computers Committee of the Institute of Radio Engineers, and the Council of the Association for Computing Machinery.

Input-output equipment presents an ever-changing and expanding problem and encompasses a very broad field of devices. This conference stressed those devices which have been brought to the point of working equipment by the various computing groups in an attempt to acquaint a large body of engineers with the present status of the art. The 142 printed pages contain 27 pages and discussions, representing a fairly complete documentation of the input-output art as it existed at the time of publication.

Publication S-53 is available at the price of $4.00 to members and nonmembers. Send orders to Order Department.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

33 West 39th Street, New York 18, N. Y.

New Products

(Continued from page 34A)

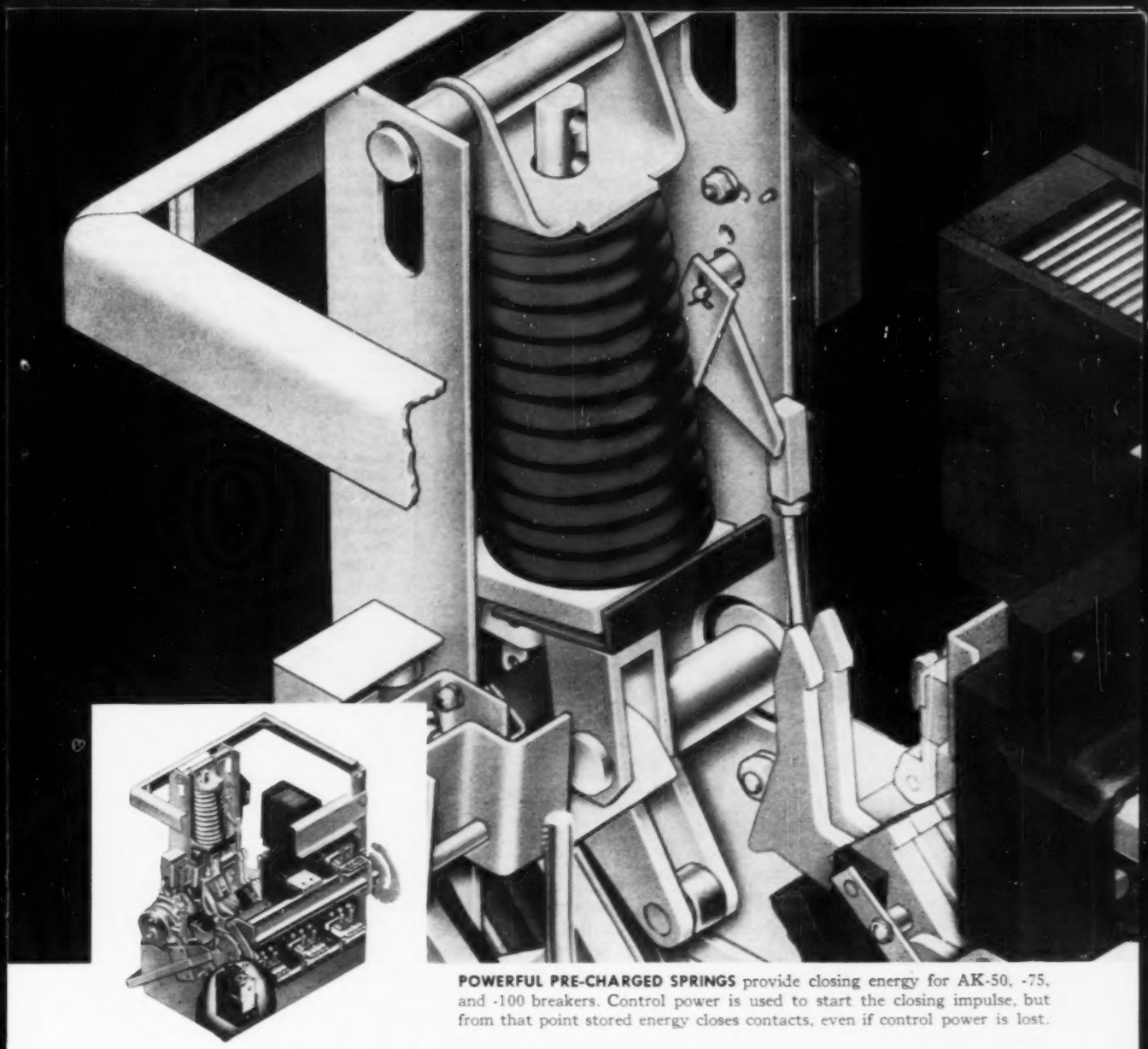
Event Recorder. This recorder, which instantly and simultaneously records up to 100 channels of on–off information in permanent chart record form, has been

announced by Brush Instruments, Division of Clevite Corporation, 3405 Perkins Ave., Cleveland, Ohio. Literature giving further information is available from the manufacturer.

Instrument Component or Color Identification Finish. A green-colored solution formulated recently is reported to produce deep, lustrous black finishes on either plain zinc die cast or zinc-plated parts in about 10 to 120 seconds of immersion time, depending on temperature range of the bath. The liquid, called Nero-Zinc, is applied to parts to be treated in the form of a bath, into which one part of the solution is added to three parts water and heated to a temperature between 110 to 150 F. For further information contact Wagner Brothers Inc., 400 Midland, Detroit, Mich.

Oil Switches and Lightning Arresters. The motor operated, type *VR* oil switch is now available in two additional models designed for manual operation. New *VM* models have a manual-remote handle and *VH* models are equipped for hook-stick operation. The 3-phase switches are rated 15 kv, 400 amperes, and 110-kv basic impulse insulation level. Another new item is the intermediate class lightning arrester that combines compactness and simplicity of design with stability of operation and excellent protective characteristics. Designated Type *F*, the arresters are unusually rugged mechanically and electrically. Available voltage ratings are 20, 25, 30, 37, 40, 50, 60, and 73 kv. For additional information write Line Material Industries, McGraw-Edison Company, Milwaukee 1, Wis.

(Continued on page 38A)



POWERFUL PRE-CHARGED SPRINGS provide closing energy for AK-50, -75, and -100 breakers. Control power is used to start the closing impulse, but from that point stored energy closes contacts, even if control power is lost.

A General Electric Feature Since 1952

STORED ENERGY MECHANISM MEANS POSITIVE CLOSING FOR AK-50, -75, AND -100 BREAKERS

Positive closing action, made possible by energy stored in a spring, gives G-E air circuit breakers the ability to close and latch against short circuits equal to the breaker's interrupting rating at 600 volts a-c —minimizes contact damage, reduces mechanical stresses, and lowers control power needs. The spring-operated stored energy closing mechanism has been proved by field applications for over five years. *Watch for coming announcements extending use of this principle.* General Electric, Schenectady 5, N.Y.

5271

Progress Is Our Most Important Product

GENERAL ELECTRIC

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CORONA

TESTING EQUIPMENT

. . . for non-destructive evaluation of electrical insulation in transformers, cables, capacitors and other electrical components.

Control cabinet and test transformer available as separate units on casters for mobility, for testing specimens with terminal capacitance up to 0.15 MUF and impedance to ground of 20,000 OHMS or more. (Power output maximum of 20 KVA at 20 KV 60 CPS.) On special order this equipment can be supplied for maximum output power at 20 KVA at maximum test voltage 30 KV 60 CPS.

Safety, simplicity, and reliability have been engineered into all Biddle Corona Testing Equipment. Care has been taken to make the indication of corona as simple and self-evident as possible.

For sensitive test equipment these sets are extremely rugged, and surprisingly easy to operate, even by personnel not specifically trained for making electrical measurements. All this without sacrificing sensitivity of corona detection and reproducibility of test results.

With the Biddle Corona Test Set non-destructive evaluation of insulation by corona testing is now practical as a production control of quality of insulating structures.

Whatever your requirements in this field of testing explore the complete line of Biddle Corona Testing Equipment—for complete details write for Bulletin 66—EE.

JAMES G. BIDDLE CO.

- ELECTRICAL TESTING INSTRUMENTS
- SPEED MEASURING INSTRUMENTS
- LABORATORY & SCIENTIFIC EQUIPMENT

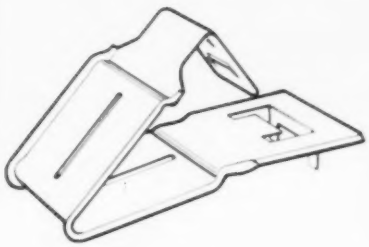
1316 ARCH STREET
PHILADELPHIA 7, PA.

New Products

(Continued from page 36A)

Aircraft Microphone Intercom Switch. An unusually small, high reliability aircraft microphone intercommunication switch is now in production at Mason Electric Corp., 3839 Verdugo Rd., Los Angeles, Calif. A momentary 2-position, split-pole switch with a snap feel, the unit needs no replacement over long periods. Operation is fail safe, direct, and fully dependable even under adverse environmental conditions, extreme overloads, and high altitudes. No relays are needed. For more information, please write to the company, attention Howard Littlefield, sales manager.

Speed Clip. Designed to accommodate and retain any of the popular single or multiple wire cord sizes for use on appliances and other products, a new speed clip has been announced by Tinnerman Products, Inc., P. O. Box 6688, Dept. 16, Cleveland 1, Ohio. The clip, with two locking steps,



is merely slipped over a wire and pre-latched or compressed to the first locking position. The new speed clip provides exceptionally fast assembly for either strain relief or plain clamping action and can be mounted anywhere and at any time before, during, or after assembly.

Push-to-Test Pilot Light. A completely new design incorporating the features of the Class *9001* Type *T* pilot light line, with a separate circuit to test the bulb, has been made available recently. The push-to-test pilot light enables the testing of the bulb simply by pushing on the color cap. In the test position there is a positive contact "feel" eliminating any doubt as to whether the unit is actually in the test position. For complete details, write for "Push-to-Test" literature, Square D Company, 4041 N. Richards St., Milwaukee 12, Wis.

12-Volt Safety Drop Cord. Electrical and safety departments responsible for the safety of personnel working in manholes, tanks, and other places that are especially hazardous electrically, will be interested in a safety drop cord just introduced. The cord provides a 12-volt 100-watt outlet from the line voltage and is said to eliminate the hazards of electric shock. For further information, contact Sittler Corporation, 18 N. Ada St., Chicago 7, Ill.

(Continued on page 40A)

the NEW AMPlivar splice plus new horizontal machine

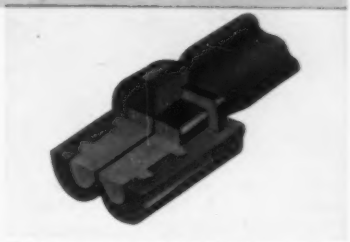
for identical, mass produced splices of enamel, poly-vinyl acetal and similarly coated wire

AMPlivar splices can be used on solid or stranded conductors, or combinations thereof.

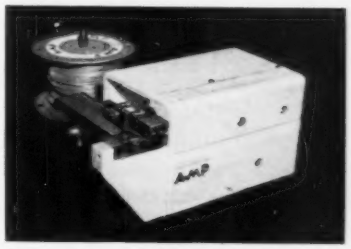
AMPlivar splices, with multiple ring stripping action, eliminate scraping, dissolving in solvents, burning, or other methods for removing insulation. Included among its many other features are:

- NO HEAT DAMAGE TO WIRE OR INSULATION—as often occurs in alternate methods of splicing.
- SMALL SIZE—scarcely larger than the wires themselves, but design-engineered to lock wire and connector into a high tensile strength splice.
- CORROSION RESISTANT—the joint is hermetically sealed during splicing.
- LOWER INSTALLED COSTS—eliminates soldering materials and equipment . . . requires less wire . . . reduces time required to make the splice.

Further information is available on request.



This cutaway of the AMPlivar splice shows how conductor material extrudes outwardly into serrations for added strength and electrical contact. The splice is as corrosion resistant as the wire itself.



IDEAL FOR ASSEMBLY LINE PRODUCTION . . . the AMP Horizontal Automachine uses AMPlivar splice connectors in strip form, for automatic splicing as fast as the operator can insert the wires.

AMP INCORPORATED AMP

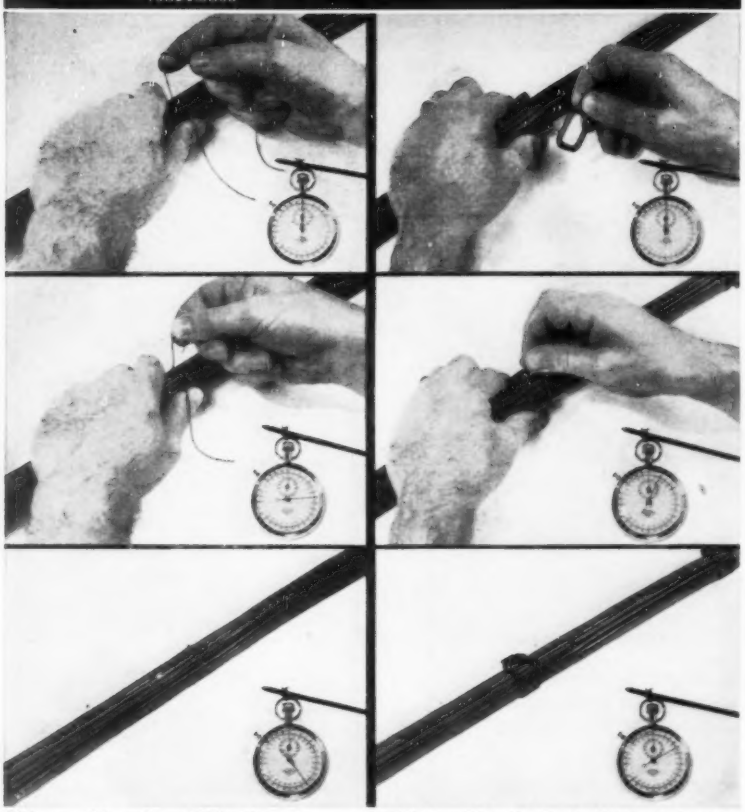
General Offices: 4112 Eisenhower Blvd., Harrisburg, Pa.

Wholly Owned Subsidiaries: Aircraft-Marine Products of Canada Ltd., Toronto, Canada • Aircraft-Marine Products (G.B.) Ltd., London, England • Societe AMP de France, Le Pre St. Gervais, Seine, France • AMP-Holland N.V., 's-Hertogenbosch, Holland • Japanese Distributor: Oriental Terminal Products Co., Ltd., Tokyo, Japan

Cut wiring time by 52% with the revolutionary NEW

Insuloid cradleclip WIRING SYSTEM

TRADEMARK



Fixing cables the old-fashioned wrap method . . . it takes an average 12 seconds per fixing point.

Fixing cables the fast, efficient Cradleclip way . . . notice it takes only 5 seconds per fixing point.

The above series of photographs dramatically illustrate the speed of installation and well-engineered appearance of the amazing "Cradleclip" Wiring System. This system consists of a series of Cradles and Binders, moulded from tough Nylon that is virtually unbreakable, and a series of Extensible Clips moulded from Neoprene that combines the right degree of toughness and flexibility to hold any type of cable securely without damage. Sizes available to meet the requirements of cable groupings having a diameter of ¼ inch to 2¼ inch. Ideal for use in all climatic conditions. Installation is fast, easy and efficient . . . the Cradles, used for anchored wiring, are screwed in position, the cables laid in place, and a Clip is hooked to the Cradle . . . for unsupported fixing, a Binder is held in place on one side of the cables and then secured in position with Clip.

Free **SAMPLES AVAILABLE**

Write today, with no obligation on your part, for your free sample kit . . . contains samples of all sizes of the Clips, Binders and Cradles.

ADVANTAGES

- **Provides high-speed, simplified wiring operation.**
- **Neat, compact, well-engineered appearance.**
- **Wiring changes can be made with extreme ease.**
- **Reduces wiring costs and speeds up production.**

A PRODUCT OF

ELECTROVERT INC.

124 EAST 40th STREET NEW YORK 17, N. Y.

Phone: OXford 7-8397

New Products

(Continued from page 38A)

Automatic Temperature Control System. A pneumatic Varitrol control system that provides controlled variable speed for fans or pumps in heat exchange processes has been developed by U. S. Electrical Motors Inc. This system is completely automatic and will hold the desired product output temperature within 1% of the desired value. The system provides accurate control and is designed to give prolonged performance with a minimum of attention. It may be used in conjunction with heat exchange systems operating at pressures up to 1,000 psi. For more information write U. S. Electrical Motors Inc., Box 2058 Terminal Annex, Los Angeles 54, Calif., and ask for Specification Sheet section 351, page 17, and Bulletin *F-1882*.

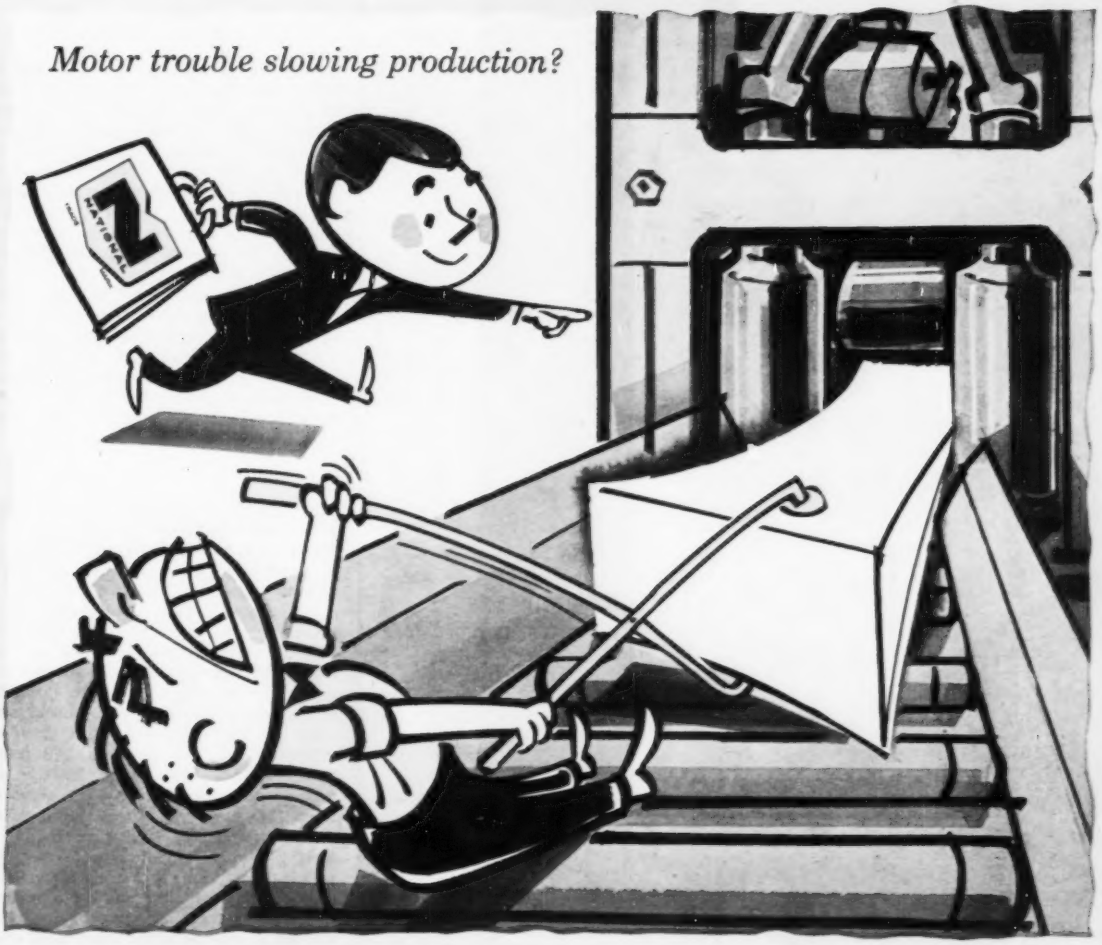
Explosionproof D-C Motor in Volume. This high-precision motor was originally designed and engineered to military and marine specifications, and for civilian commercial service. Now standardization of basic component parts, with complete precision tooling, permits its manufacturer to produce it in volume. The unique features of this explosionproof motor, with ratings from 1/20 to 3 hp, make it possible to retain its flexibility for custom designs. For literature and additional information, write to Piqua Machine and Manufacturing Company, Young & Thomas, Piqua, Ohio.

High-Intensity Light in Track Aid. Keeping an eye on an airborne drone, missile, target plane, or balloon is aided markedly by a new tracking device introduced by Research, Incorporated, 115 N. Buchanan Ave., Hopkins, Minn. Brilliant, short-duration flashes of light achieve maximum visibility and recognition with minimum power drain. Consisting of a photoflash lamp assembly and a pulsing circuit that may be remotely located, the entire equipment weighs only 4 pounds and is avilable for 28-, 14-, or 7-volt d-c systems.

Compact Radiation-Cooled Triode. The most compact, radiation-cooled, high-power industrial triode, Type *7092*, has been announced. The internal anode, Type 7092, is designed for industrial oscillator applications in ultrasonic, induction, or dielectric heating equipment. Since the tube does not require water cooling, the *7092* has lower initial and operating costs than similarly rated tubes, with savings of approximately 40% in tube and accessory costs. Used in continuous Class C operation, 2 kw power into industrial loads can be obtained, and 3 kw in intermittent operation. The thoriated-tungsten filament is rated at 6.3 volts, 32.5 amperes. The triode is immediately available from stock. For further information, write: Industrial Tube Division, Amperex Electronic Corporation, 230 Duffy Ave., Hicksville, L. I., N. Y.

(Continued on page 42A)

Motor trouble slowing production?



Your NATIONAL brush man helped solve this slowdown problem!

JOHN BEHEN

Motor trouble at this 44″ steel mill caused one costly slowdown after another, says "National" Carbon Brush Man, John Behen. Source of the production trouble – excessive film build-up on one of the mill's edger motors.

The mill tried several brushes to alleviate this condition but with no success. They called in John Behen who analyzed the operation and recommended the proper "National" brush grade. *Result:* a 100 ton increase in daily production thanks to trouble-free motor performance. Incidentally, John went on to solve similiar brush problems on 3 of the steel mill's 5,000 amp motor-generator units.

John Behen and his fellow "National" Carbon Brush Men have been solving industrial brush problems for years. Their experience and training – backed by "National" *long term brush development* – make them the logical consultants on any industrial brush problem.

Call your "National" Carbon Brush Man today. Or write National Carbon Company, Division of Union Carbide Corporation, 30 E. 42nd St., New York 17, N.Y.

The terms "National", "N" and Shield Device, and "Union Carbide" are registered trade-marks of Union Carbide Corporation

NATIONAL CARBON COMPANY • Division of Union Carbide Corporation • 30 East 42nd Street, New York 17, N. Y.

UNION CARBIDE

Sales Offices: Atlanta, Chicago, Dallas, Kansas City, Los Angeles, New York, Pittsburgh, San Francisco. *In Canada:* Union Carbide Canada Limited, Toronto.

ONE
makes
FOUR
FOUR distinct divisions in one steel company, inter-related, specialists in their own field of endeavor and singly managed.
Some clients take advantage of all four, others one or more.

STRUCTURAL & REINFORCING DIVISION
Fabricated structural and reinforcing steel for buildings, bridges, and industrial structures.

TOWER & SUBSTATION DIVISION Substation structures and transmission towers for the electrical and communications industry. (sold and shipped competitively everywhere).

PLATE DIVISION Fabricated plate products for the oil, chemical and processing industries.

STEEL WAREHOUSE DIVISION Distributors of carbon steel and construction products.

for over 40 years

FLINT STEEL CORPORATION

TULSA . . . MEMPHIS

New Products

(Continued from page 40A)

Rubber Mountings Withstand Temperature Extremes. Recent announcement of bonded rubber vibration and shock control mountings which can be produced to operate efficiently from —65 F up to +300 F was made. These mountings, utilizing a new broad temperature range elastomer, have the ability to withstand temperature extremes with minimum changes in physical properties. Transmissibility at resonance is 3 or less at 68 F; it is less than 3.5 at +300 F. In addition, the broad temperature range elastomer is resistant to oil and ozone, and has high tensile strength, high tear resistance, and good flex life. Inquiries should be directed to Russell E. Ricketts, Adv. Mgr., Lord Manufacturing Company, 1635 W. Twelfth St., Erie, Pa.

Nylon-Insert Locknut. A line of nylon insert locknuts of attractive design have a die-cast zinc alloy hexagonal nut body and a molded nylon compression collar for locking elements. The new locknut is made by a special manufacturing approach which firmly anchors the unthreaded nylon collar in the nut body in a unique manner in order to prevent the collar from turning or breaking out. The nylon locking element maintains a constant grip on the screw threads, dampens vibration, seals out moisture, and resists loosening. The nylon collar tends to return to its original shape when removed from the screw permitting reuse many times without appreciable reduction in locking torque. The locking effect exists at any point along a mating screw even if not tightened down against a seating surface. This new locknut will not cause damage to mating screw threads. A complete range of thread sizes from No. 4 to ½ inch is planned and in preparation. Samples are available upon request from the manufacturer, 400 Beechwood Ave., New Rochelle, N. Y.

Metal Joining Material. Intertectics, Incorporated, Northfield and Forbes Rds., Bedford, Ohio, has announced the development of a joining material and new industrial technique for the chemical union of similar and dissimilar nonferrous metals. Use of this new material, called "InterAct," is expected to create revolutionary changes in methods of joining nonferrous metals in the aircraft, automotive, appliance, construction and electrical manufacturing industries, missile fabrication, and many other types of industry. InterAct makes commercially feasible, the chemical joining of copper and aluminum, until now possible only by mechanical means. The new material also forms a permanent chemical bond through ion exchange between such materials as magnesium, titanium, brass, zinc, silver, and gold. The resulting joint is usually stronger than either of the metals involved, is frequently greater in corrosion resistance, and has similar electrical, physical, and chemical properties.

Hughes
Quick Recovery
Silicon Junction
Diodes

HIGH SPEED
HIGH TEMPERATURE
HIGH VOLTAGE

Now, in circuits where germanium once provided the only possibility, you can use quick recovery silicon diodes from Hughes. Speeds are fast enough for most high frequency or fast switching applications. And every diode is well able to stand up under high voltages at high temperatures. In fact, the breakdown voltage *increases* with temperature, thereby providing maximum protection when temperatures reach unexpected levels. This is real ruggedness, the kind that ensures reliability under the most severe operating conditions.

NEW HIGHER CONDUCTANCE TYPES — Here's a new group of related diodes, each with excellent voltage and temperature characteristics plus the added advantage of higher forward current.

*Special high conductance types are available in *all* voltage classes covered by the standard line.

SPECIFICATIONS*

Type Numbers	PIV (min.)	Forward Current @ 1.5V (min.)	Reverse Current at Specified Voltage @ 25°C (max.)	@ 100°C (max.)	Recovery (mod. IBM "Y" test circuit)
1N625	30V	4mA	1 μA @ −10V 10 μA @ −20V	50 μA @ −20V	15 KΩ (min.) in 0.15 μsec
1N626	50V	4mA	20 μA @ −35V	100 μA @ −35V	400 KΩ (min.) in 1 μsec
1N627	100V	4mA	20 μA @ −75V	100 μA @ −75V	400 KΩ (min.) in 1 μsec
1N628	150V	4mA	20 μA @ −125V	100 μA @ −125V	400 KΩ (min.) in 1 μsec
1N629	200V	4mA	20 μA @ −175V	100 μA @ −175V	400 KΩ (min.) in 1 μsec
HD6573	150V	6mA	20 μA @ −125V	100 μA @ −125V	400 KΩ (min.) in 1 μsec
HD6635	50V	15mA	20 μA @ −35V	100 μA @ −35V	400 KΩ (min.) in 1 μsec
HD6641	150V	15mA	20 μA @ −125V	100 μA @ −125V	400 KΩ (min.) in 1 μsec
HD6642	50V	6mA	20 μA @ −35V	100 μA @ −35V	400 KΩ (min.) in 1 μsec

Ambient Operating Temperature Range: −80°C to +150°C

Perhaps you would like to discuss your particular requirements with us. If so, please write:

SEMICONDUCTOR DIVISION • HUGHES Aircraft Company
International Airport Station, Los Angeles 45, California

Creating a new world with ELECTRONICS

HUGHES PRODUCTS

HUGHES SEMICONDUCTORS

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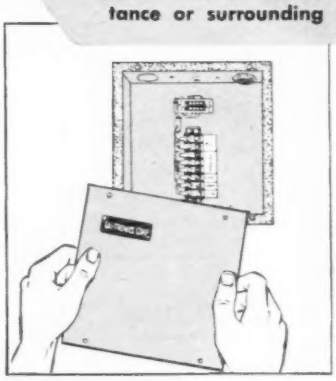
* an effective, economical industrial communication system designed to provide swift and sure voice communications regardless of distance or surrounding noise conditions.



GTC completely eliminates the need for costly, space consuming central control panel equipment and complicated wiring. Just two pairs of unshielded wires run between stations. The inconvenience and expense of vacuum tube failure is now a thing of the past.

GTC Handset Stations and Loudspeaker Amplifier Assemblies may be installed and field-wired anywhere. Merely "plug-in" amplifier units when ready to use. Installation, maintenance and expansion costs are drastically reduced.

GAI-TRONICS
CORPORATION
Dept. B
READING, PENNA.
A SUBSIDIARY OF GILBERT ASSOCIATES, INC. ENGINEERS AND CONSULTANTS

GTC is extremely flexible in application. Write today for a copy of our completely illustrated, descriptive booklet. It's yours free by return mail.

TRADE LITERATURE

Plastics Folder. A full-color folder which points the way to new products, new uses, and new markets through the use of Plaskon molding compounds has been prepared for designers, molders, and manufacturers. Products made of Plaskon urea, melamine, and alkyd molding compounds and Plaskon nylon molding and extrusion compounds are listed and illustrated. Outstanding properties which make each molding compound ideal for these specific applications are briefly described. Designated *P-95*, the folder is offered by Barrett Division, Allied Chemical & Dye Corp., 40 Rector St., New York 6, N. Y.

Adjustable Speed Drive Selector. *GEN-169*, a slide rule type plastic device designed to assist in selecting the proper motor, control panel, and operator's station of a general-purpose Thymotrol (registered trade mark) adjustable speed drive. The selector covers both fractional and integral drives up to 3 hp. By setting the slide at the desired horsepower, appropriate ratings, frame sizes, dimensions, and model numbers can be rapidly determined. Also included in the fold-out selector are lists of standard and optional features, performance characteristics, and ordering instructions. The selector is available at General Electric apparatus sales division district offices, or write to General Electric Company, Schenectady 5, N. Y.

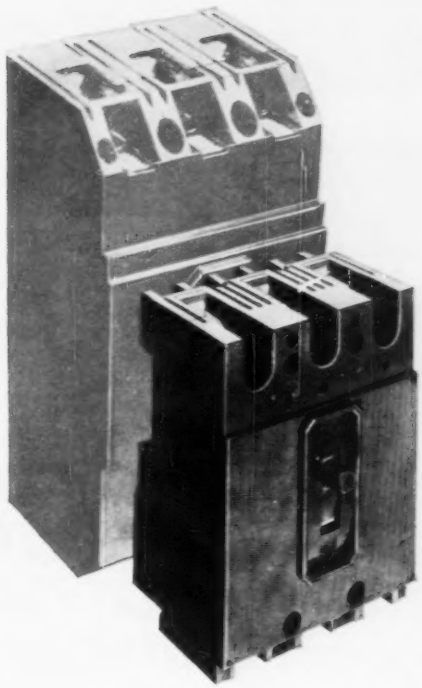
Wide-Range Pulse Generator Bulletin. A wide range pulse generator, Type *1006*, is illustrated and described in a technical bulletin released by the Burroughs Corporation, Electronic Instruments Division, 1209 Vine St., Philadelphia 7, Pa. The unit discussed in the bulletin produces a stable source of pulses in eight overlapping frequency ranges up to 4.5 mc. Its output may be a continuous train of pulses controlled by selecting one of the eight frequency ranges or a single pulse controlled by pressing a pushbutton on the front panel. The output pulse is either a positive or a negative half sine wave of 0.1 μsec duration whose amplitude is variable from 8 to 30 volts. Free copies of this bulletin are available upon request to the company.

Instrumentation Tape Bulletin. Magnetic tapes for instrumentation recording are the subject of an illustrated booklet free upon request from Minnesota Mining and Manufacturing Co., Dept. A7-306, St. Paul 6, Minn. The 8-page booklet covers six types of "Scotch" brand instrumentation tapes for use in telemetering and airborne recording, machine tool control systems, computers, geophysical recording, and other instrumentation applications. Included are charts listing physical and magnetic properties of each of the precision tapes and a comparison chart summary of major factors in selecting a tape for a particular application.

(Continued on page 50A)

NEW!

I-T-E ANNOUNCES NEW 100 amp 480 V "EH" FRAME CIRCUIT BREAKER



Reduces mounting space requirement by 40%

Recognizing industry requirements for an intermediate, compact 100 amp frame 480 v breaker, I-T-E engineers have designed a new "EH" frame molded case circuit breaker which requires 40% less mounting space than breakers previously employed to meet the rating capacity.

The new "EH" frame breaker is ideal where intermediate voltage and interrupting ratings must be handled, and space is at a premium. Specify the I-T-E "EH" frame and benefit from the compact design advantages which this new circuit breaker provides.

Contact your local I-T-E sales office or write I-T-E Circuit Breaker Company.

I-T-E

SMALL AIR CIRCUIT BREAKER DIVISION

I-T-E CIRCUIT BREAKER COMPANY

19TH AND HAMILTON STREETS, PHILADELPHIA 30, PENNSYLVANIA

COMPLETELY SEALED

100% CLASS H INSULATION

OUTDOOR AND INDOOR USE

HERE IS A DRY TYPE DISTRIBUTION TRANSFORMER THAT HAS EVERY FEATURE YOU WANT...

- Totally sealed construction keeps out moisture and dust. No need to clean coils.
- Class H insulation throughout will withstand 150° C. temperature rise on windings. Enclosure temperature rise only 40° C.
- Completely weather proof; can be used outdoors as well as indoors.
- Quickly installed in most convenient location. Only three points for bolting to column, beam or wall.
- Spacious wiring compartment allows ample working room for making connections and installing conduit.
- Solderless, clamp type connector terminals on rigid insulating board facilitates making secondary connections. No joint taping necessary.
- Complete connection diagrams and technical data permanently available on etched metal nameplate.
- Knockouts are conveniently located on sides, back and bottom to simplify conduit installation.
- Transformer cases are metal primed and finished with three coats of quality metal paint NEMA indoor gray.
- No price increase over ventilated class B types.

Prompt Shipments is our Specialty!

Available in single phase, 5 KVA, 7½ KVA and 10 KVA: Three phase 9 KVA and 15 KVA 600 volts and below. All units carried in stock for immediate shipment. If stock is temporarily depleted units in production can be shipped promptly.

ACME ELECTRIC CORPORATION
221 WATER ST. CUBA, NEW YORK

Acme ACME Electric
TRANSFORMERS

Qualified Engineers!

Engineering Societies Personnel Service

Job Opportunities

New York
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Thousands of positions available with leading firms here and abroad

Employer pays fee in many cases

World-wide contacts and affiliations

Write for weekly E.S.P.S. Positions Bulletin

See Personnel Section of this magazine for partial listing of jobs

Register Today

For the least expensive and finest terminal blocks—superior to any, made in screw, solderless connector or aluminum type use the Add-A-Point made by . . .

THE WAMA COMPANY
BALTIMORE 2, MARYLAND

For a free sample, please write to Dept. E

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Name .....
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0-57

INDUSTRY'S MOST ADVANCED DESIGN!

(Patent No. 2,790,882)

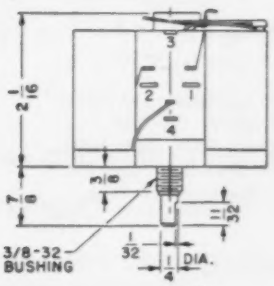
OHMITE® v.t. VARIABLE Transformer

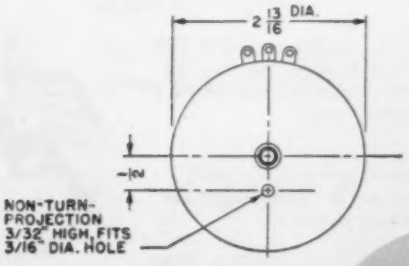
FRONT VIEW
(unmounted)

MORE CAPACITY FOR EQUAL SIZE

MODEL VT1R5—1.5 AMPERES. The rating of 1.5 amperes represents a continuous current rating at any brush setting even at full overvoltage! This "bonus" in current capacity is the result of a unique core design by Ohmite. This new component from Ohmite is made to the same high standards as the famous Ohmite resistors, rheostats, and other components. Other models in larger sizes will be announced soon.

Direct reading dial is calibrated to 120 on one side—132 on the other, for line or overvoltage connections respectively.





In addition to its greater capacity for equal size, the new Ohmite VARIABLE TRANSFORMER, representing industry's most advanced design, features the following quality features:

- *Heavily Plated Rhodium Brush Track* . . . Generous, nonoxidizing plating assures unsurpassed life under demanding conditions.
- *Positive Current Transfer* . . . The contact arm carries no current in this unit! A pigtail shunts the current from the brush, directly to a large copper-graphite slip ring which contacts a large area of the terminal. The spring-like contact arm provides its own completely independent pressure.
- *Rugged INTERNAL Stop* eliminates possibility of damage to contact arm and brush due to application of torque at rotation limits.
- *Ceramic Hub* . . . Mounts and aligns the contact arm, provides 3000 volts ac insulation between parts at line potential and shaft.

AVAILABLE FROM STOCK:
SPECIFICATIONS—MODEL VT1R5
INPUT VOLTAGE—120V, 60 CYCLE.
MAX. OUTPUT AT ANY BRUSH SETTING—1.5 AMPS. OUTPUT VOLTAGE—0-132—0-120.
ANGLE OF ROTATION—320°.
Includes knob, reversible dial plate, washer and nut.
Tandem assemblies available soon.

BACK VIEW

WRITE FOR BULLETIN 151

OHMITE v.t. VARIABLE TRANSFORMER

OHMITE® QUALITY Components

RHEOSTATS • RESISTORS • RELAYS • TAP SWITCHES • TANTALUM CAPACITORS • VARIABLE TRANSFORMERS

OHMITE MANUFACTURING COMPANY
3614 Howard Street, Skokie, Illinois

NOTHING TAKES THE PLACE OF...

NINE YEARS PROVE THAT NOTHING EQUALS Amp-trap's CURRENT LIMITING ABILITY AND WIDE SCOPE OF APPLICATION

1948 - Form 600 - General Power Circuits

Amp-trap® — Form 600. Provides back-up protection for circuit breakers, motor starters and distribution equipment. Prevents thermal and mechanical damage from short circuits with high available current. Runs "cool." (Ask for Bulletin No. 514-7)

1951 - Form 1000 - D.C. Circuits up to 750 1000 Volts

Available in Ampere Ratings of 60, 100, 200, 400, 800 and 5000. Interrupts up to 85,000 Amperes at 1000 Volts. (Ask for special information)

1952 - Form 208 - Networks, Entrance Switches, etc.

Amp-trap® — Form 208 — For 120/208 Volt A.C. Circuits. Interrupts up to 560,000 Amps. *Anticipates* and *prevents* build-ups of heavy fault currents and gives arcing fault protection. Runs "cool" because it has very low watt loss. (Ask for Bulletin No. 514-8)

1953 - Form 101 - General Electronic Applications: Semi-Conductors, Diodes, Transistors, etc.

Amp-trap® — Form 101 — For 65/130/250 Volt circuits in rectifier, electronic and power applications. Built in many ratings such as 1, 2, 4, 5, 7, 8, 10, 12, 15, 20, 30, 100, 150, 250, 300, 350, 400, 600, 800, 1000, 1200, 1500, 2000, 2500, 3000, 3500, 4500, 5000, 6000, 8000 and 10,000 Amps. Interrupting tests in the highest power ranges show that Form 101 becomes current limiting at about 4 times its normal current rating. This has never been achieved by any other protective device. (Ask for latest bulletin.)

1954 - Form 480 - For the New Higher Voltage Networks, Busways, etc.

Amp-trap® — Form 480 — For A.C. circuits up to 600 Volts — D.C. circuits up to 250 Volts. Made the 480/277 (now 460/265) Volt high power network systems possible. Interrupting tests up to 500,000 Amps. prove that this is the only Current Limiter that meets this system's requirements for both interrupting and arcing fault protection. Runs "cool." (Ask for Bulletin No. 514-9)

When you want to *anticipate* and *prevent* destruction from current or arcing faults in all general power or electronic circuits, call on us here at Chase-Shawmut. We'll help select the right Amp-trap for your particular application. There is one for every purpose.

®*Amp-trap* is a registered trade name of The Chase-Shawmut Co. and refers to a current limiting device and herein is written Amp-trap.

Amp-trap is covered by one or more of the following patents: 2,557,926; 2,592,399; 2,594,315; 2,599,646; 2,647,970; 2,653,203; 2,658,974; 2,662,140; 2,665,348; 2,670,418; 2,681,398; 2,703,352; 2,713,098; 2,734,110; 2,734,111; 2,734,112; 2,740,187; 2,740,735; 2,761,932; 2,770,757; 2,777,033; 2,781,434; 2,794,095; 2,794,096; 2,794,098; 2,794,099; 2,794,883.

Amp-trap®

CURRENT LIMITERS
(not fuses)

Available in Ratings from ¼ Amp. to 10,000 Amps.

FOR POSITIVE **PROVEN** PROTECTION ON **ALL** GENERAL POWER AND ELECTRONIC CIRCUITS

- **The ORIGINAL Current Limiter with ratings up to 5000 Amperes.**
- **The ONLY complete line of Current Limiters.**
- **The ONLY Current Limiter that has been proved both in the laboratory and on-the-job again and again.**
- **The ONLY Current Limiter that can interrupt 200,000 Amperes symmetrical over the entire Ampere Range.**

The Amp-trap is a true Current Limiter because it *stops* dangerous short circuit currents before they become destructive. Fuses can not do this on high power circuits.

REGISTERED U.S. PATENT OFFICE — Est. 1893

AMP-TRAPS — *"Awake At The Switch"*

THE CHASE-SHAWMUT CO.

373 MERRIMAC STREET • NEWBURYPORT, MASSACHUSETTS

Represented in Canada by Powerlite Devices, Ltd.

Subsidiary of I-T-E CIRCUIT BREAKER CO., Philadelphia, Pennsylvania

© 1957 The Chase-Shawmut Co.

TELEPHONE AND TELEGRAPH EQUIPMENT

Radio Engineering Products is currently producing a number of types of equipment, electrically and mechanically interchangeable with standard Bell System apparatus.

CARRIER-TELEPHONE EQUIPMENT

C5 Carrier-Telephone Terminal (J68756). A kit for adding a fourth toll-grade channel to existing C systems is available. • C1 Carrier-Telephone Repeater (J68757) • 121A C Carrier Line Filter • H Carrier Line Filter (X66217C).

CARRIER-TELEGRAPH EQUIPMENT

40C1 Carrier-Telegraph Channel Terminal (J70047C) • 140A1 Carrier Supply (J70036A1, etc.) • 40AC1 Carrier-Telegraph Terminal.

VOICE-FREQUENCY EQUIPMENT

V1 Telephone Repeater (J68368F) • Power Supply (J68638A1) • V1 Amplifiers (J68635E2 and J68635A2) • V3 Amplifier (J68649A) • V-F Ringers (J68602, etc.) • Four Wire Terminating Set (J68625G1) • 1C Volume Limiter (J68736C).

D-C TELEGRAPH EQUIPMENT

16B1 Telegraph Repeater (J70037B) • 10E1 Telegraph Repeater (J70021A) • 128B2 Teletypewriter Subscriber Set (J70027A).

TEST EQUIPMENT

2A Toll Test Unit (X63699A) • 12B, 13A, 30A (J64030A) and 32A (J64032A) Transmission Measuring Sets • 111A2 Relay Test Panel (J66118E) • 118C2 Telegraph Transmission Measuring Set (J70069K) • 163A2 Test Unit (J70045B) • 163C1 Test Unit (J70045D).

COMPONENTS AND ACCESSORIES

255A and 209FG Polar Relays • Repeating and Retard Coils, several types • 184, 185, 230A and 230B Jack Mountings.

RADIO ENGINEERING PRODUCTS
1080 UNIVERSITY ST., MONTREAL 3, CANADA
TELEPHONE UNiversity 6-6887 — CABLES RADENPRO, MONTREAL

Trade Literature

(Continued from page 44A)

Small Tool Catalog. A 184-page catalog No. *216* describes and illustrates small tools and precision equipment designed for work on small instrument parts and allied uses. Free to rated companies upon request on letterhead. C. & E. Marshall Co., Box 7737, Chicago 80, Ill.

Film Cleaning Booklet. The most up-to-date information available on the use and application of Freon-TF (registered trade mark) solvents to motion picture film cleaning is presented in a booklet which lists chemical and physical properties of the solvent and tells how to use it in both hand cleaning and machine cleaning equipment. For further information contact E. I. du Pont de Nemours & Co. (Inc.), 2420-11 Nemours Building, Wilmington 98, Del.

Corrosion Resistant Solid-Film Lubricant. A long series of tests has been completed on the latest one-coat "corrosion resistant" solid-film lubricant manufactured by Electrofilm, Inc., P. O. Box 106, North Hollywood, Calif. This new formula, labeled *66-C*, meets all the requirements of *MS L-25504* without sacrificing either the long wear life or frictional properties inherent in other solid-film lubricants. For additional information write to the company for Electrofilm Technical Bulletin No. *2055*.

X-ray Process Control Folder. A 4-page folder titled "Putting the X-ray Spectograph into the Process Control Loop" is available gratis from the Instruments Division, Philips Electronics, Inc., 750 S. Fulton Ave., Mount Vernon, N. Y.

Microfilm Systems Reprints. A series of 20 reprints of articles relating to uses of microfilm and Filmsort aperture cards and jackets in engineering department and general office procedures has been prepared by the Filmsort Division, Dexter Folder Company (a Division of Miehle-Goss-Dexter, Inc.), 50 S. Pearl St., Pearl River, N. Y. The articles, most of them case histories of control, filing, and reproduction of microfilmed drawings and records, are from recent technical journals and business magazines. These reprints will be available without charge to management, engineers, and system and methods men.

(Continued on page 54A)

AIEE TRANSACTIONS

Volume 75 of the 1956 Transactions containing all the technical papers approved by the Technical Committees which were presented during the year is now ready for distribution.

The Transactions are a complete record of advancement in the art of electrical engineering during the year.

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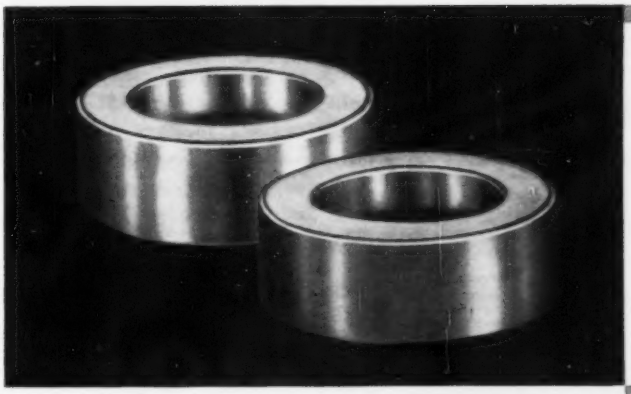

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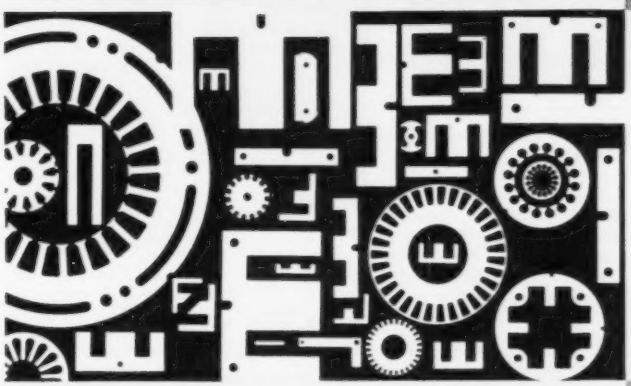

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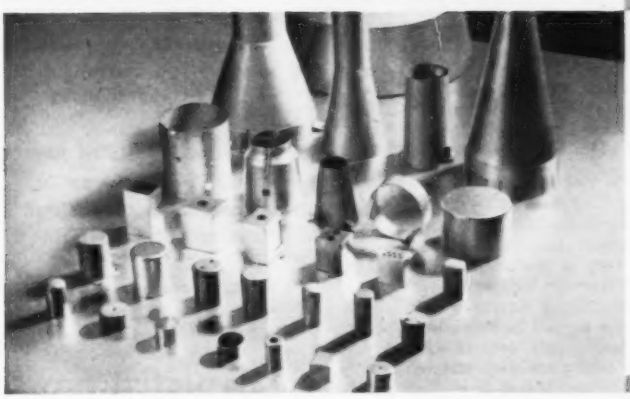

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(Continued from page 50A)

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(Continued on page 72A)

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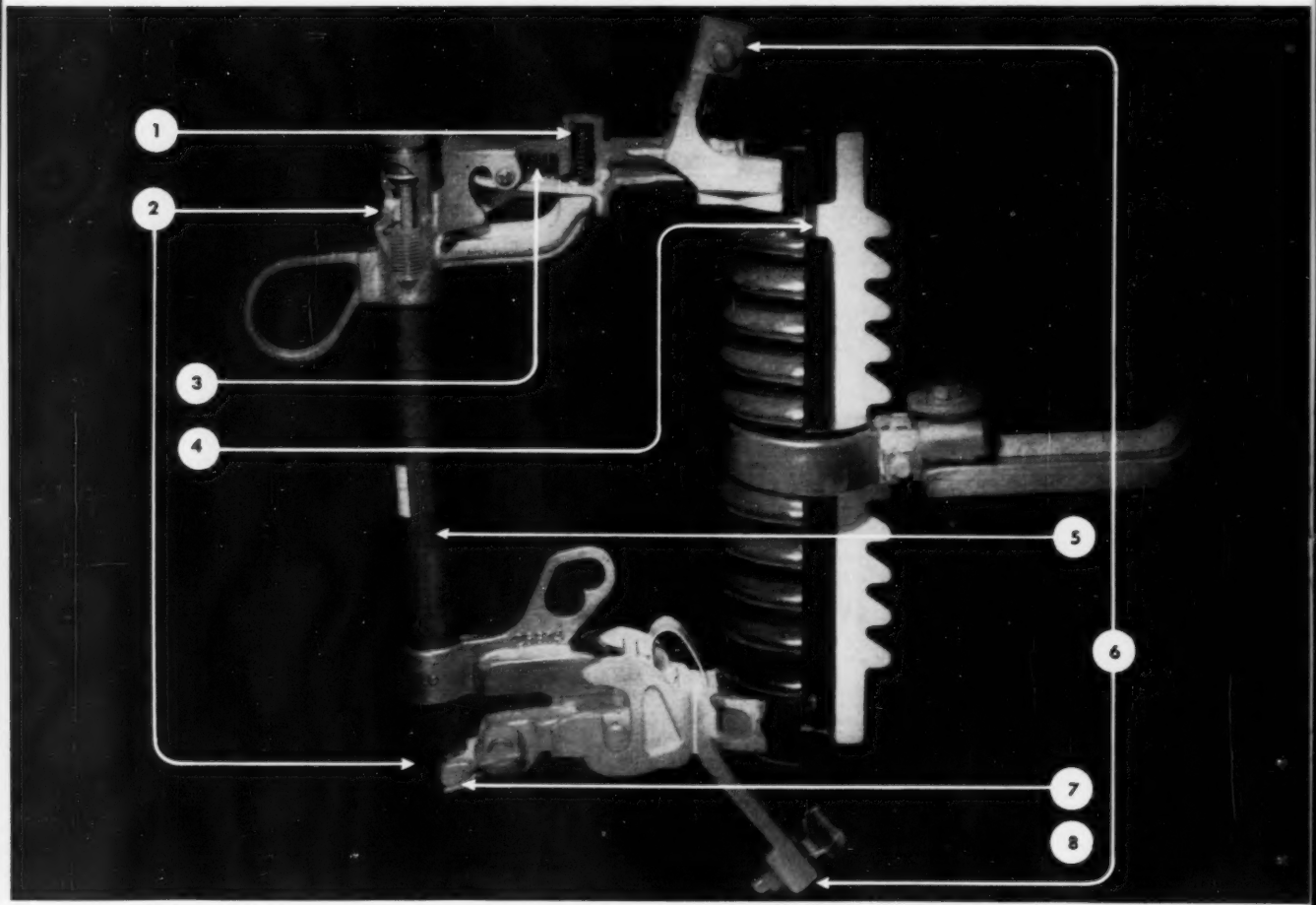

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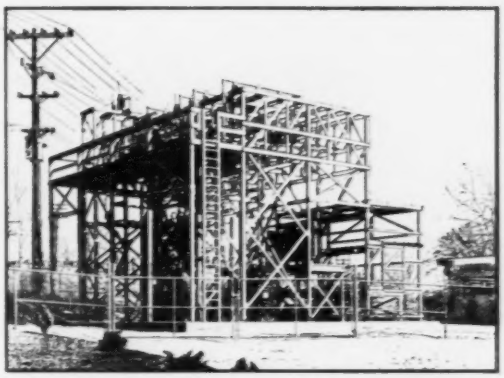

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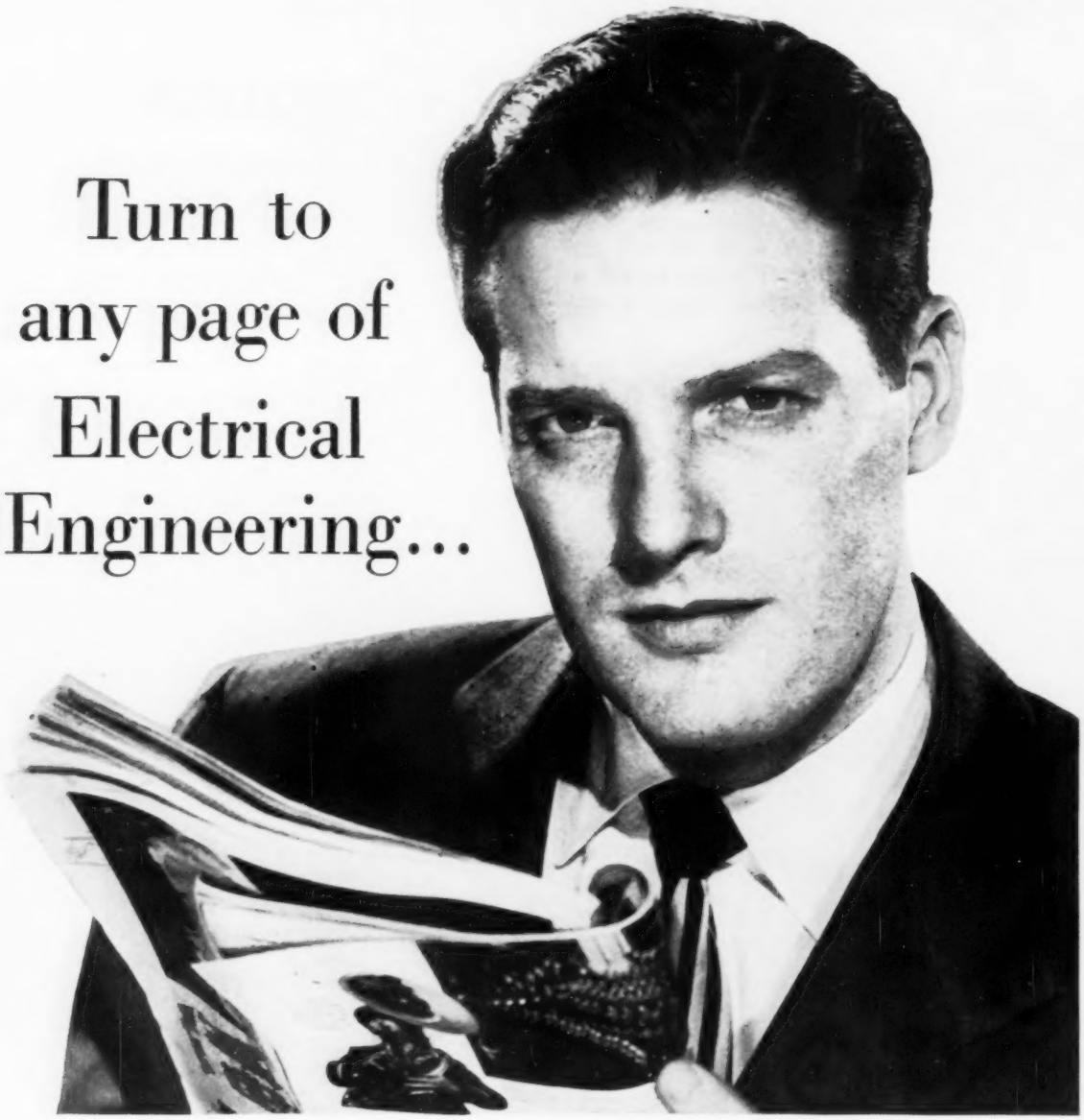

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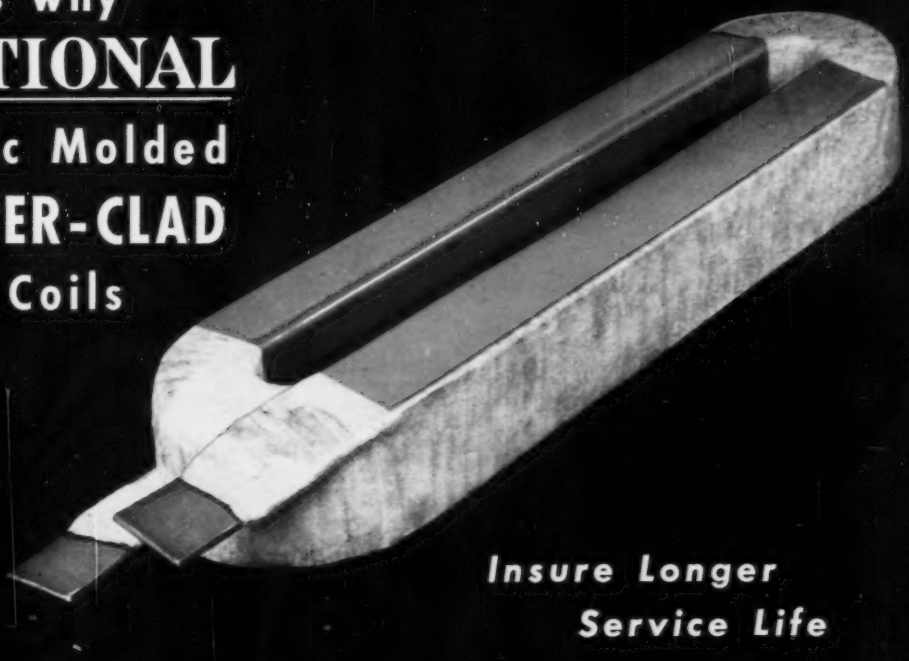

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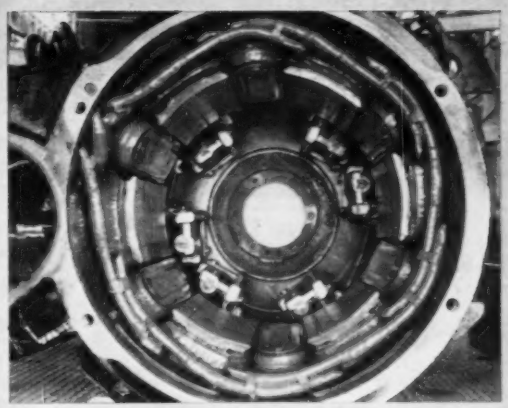

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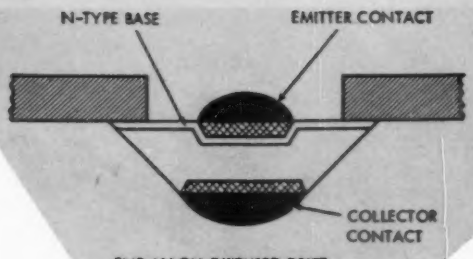

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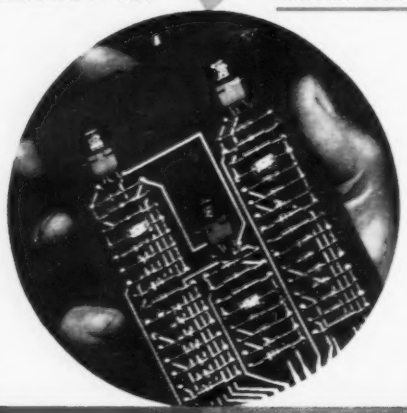

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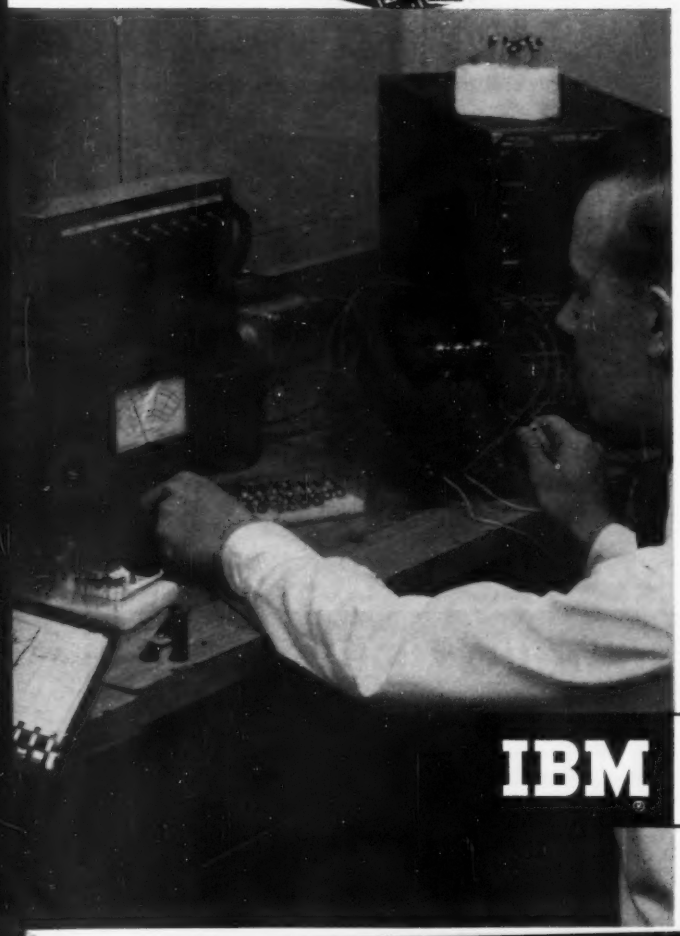

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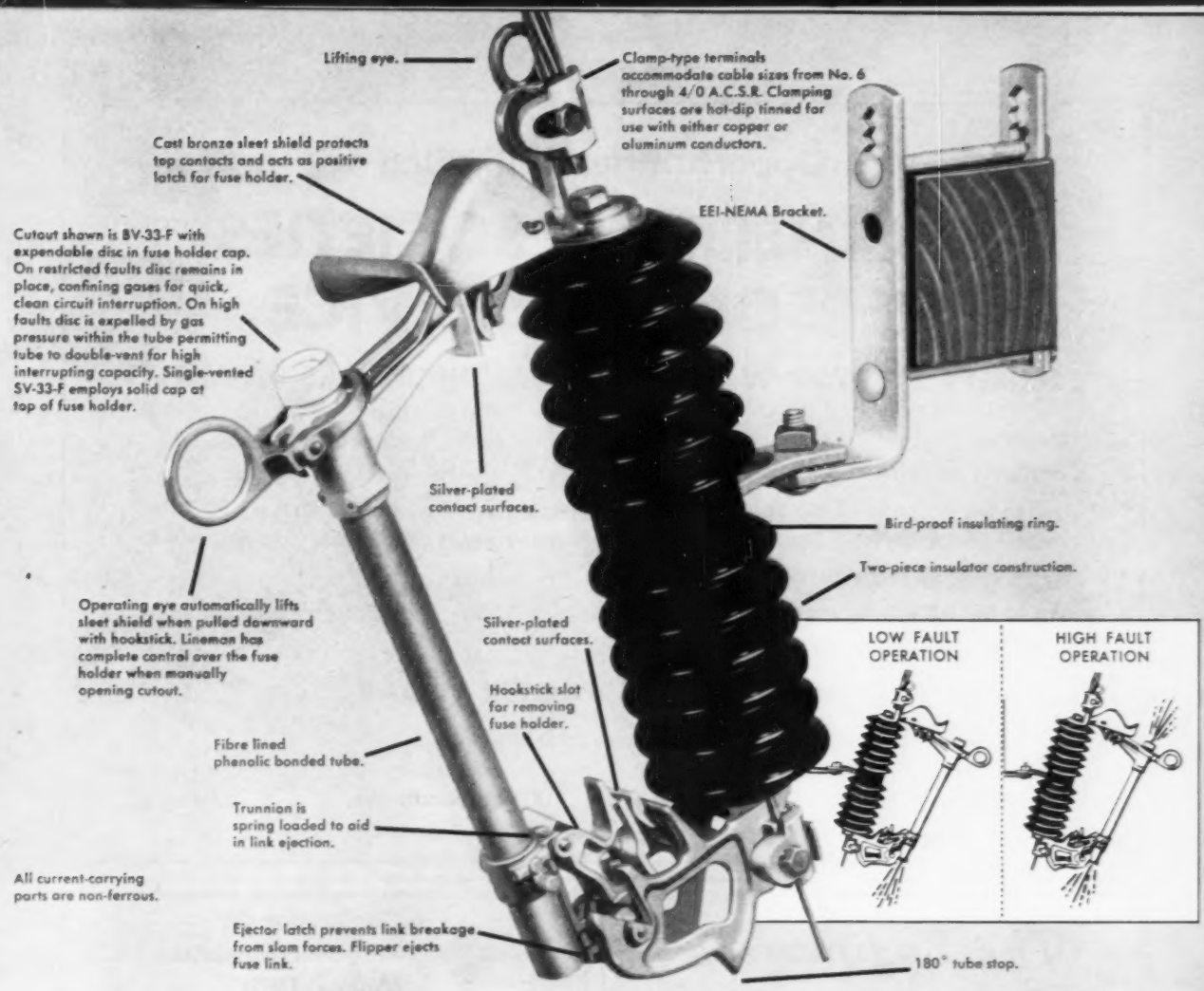
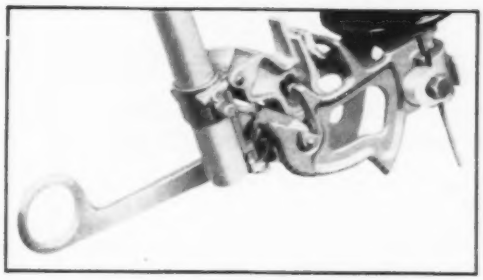

Lifting eye.
Clamp-type terminals accommodate cable sizes from No. 6 through 4/0 A.C.S.R. Clamping surfaces are hot-dip tinned for use with either copper or aluminum conductors.
Cast bronze sleet shield protects top contacts and acts as positive latch for fuse holder.
EEI-NEMA Bracket.
Cutout shown is BV-33-F with expendable disc in fuse holder cap. On restricted faults disc remains in place, confining gases for quick, clean circuit interruption. On high faults disc is expelled by gas pressure within the tube permitting tube to double-vent for high interrupting capacity. Single-vented SV-33-F employs solid cap at top of fuse holder.
Silver-plated contact surfaces.
Bird-proof insulating ring.
Two-piece insulator construction.
Operating eye automatically lifts sleet shield when pulled downward with hookstick. Lineman has complete control over the fuse holder when manually opening cutout.
Silver-plated contact surfaces.
LOW FAULT OPERATION
HIGH FAULT OPERATION
Hookstick slot for removing fuse holder.
Fibre lined phenolic bonded tube.
Trunnion is spring loaded to aid in link ejection.
All current-carrying parts are non-ferrous.
Ejector latch prevents link breakage from slam forces. Flipper ejects fuse link.
180° tube stop.

Southern States new cutout offers double action for double protection



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For complete details, see your local Southern States representative, or write direct for Bulletin 570-C.

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Conference on Magnetic Amplifiers (August 1957)

Publication T-98 is sponsored jointly by the American Institute of Electrical Engineers, Committee on Magnetic Amplifiers, and by the Institute of Radio Engineers, Professional Group on Industrial Electronics. The Special technical conference on magnetic amplifiers was held in Pittsburgh, Pa., September 4-6, 1957. The 264-page proceedings consist of 18 informative papers. Price $4.00. Send orders to:

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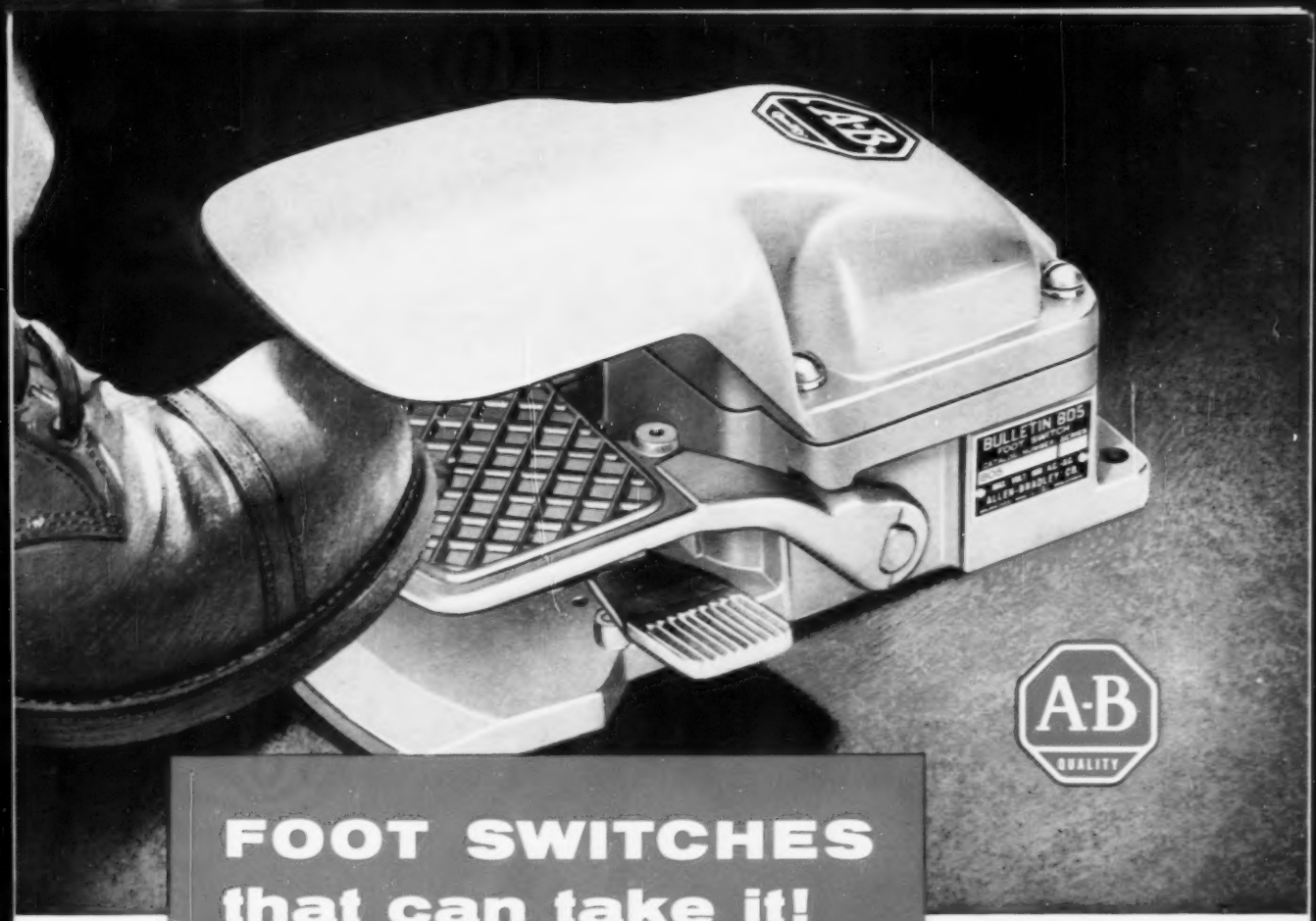
The Educational Committee of the Power and Industrial Division, AIEE New York Section, presented a Special Study Group in Spring 1956 in which technical data on the jointing of copper and aluminum conductors of all types was "packaged" for the first time.

The "Jointing" texts from eight lectures, have been assembled in a practical 54-page guide on the subject of electrical connector design and application, with specific reference to aluminum and aluminum-copper connections. Price: $2.25. Publication S-94 may be obtained from: Order Department, AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, 33 West 39th Street, New York 18, N. Y.



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• **VERSATILE OPERATION**—The contact trip point is easily adjustable. When equipped with two contact blocks, this foot switch can be set for simultaneous or two-stage operation. The Bulletin 805 foot switch can also be furnished with a latch to provide maintained contact operation. In addition, this latch, when desired, can be made inoperative, and may be quickly changed from one to the other side of the foot switch.

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Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis.
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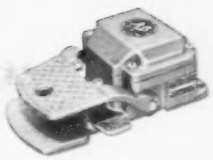

Bulletin 805 Style A switch with latch.

Bulletin 805 Style A switch with latch and top guard to prevent accidental operation.

Bulletin 805 Style A switch with latch and guard covering both top and sides.

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IN A THOUSAND AND ONE TYPES

A-B
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Roller fork type in watertight enclosure.
Lever type for rod or chain operation.
Push type, heavy duty switch.
Center roller, standard duty switch.
Switch with two independently adjustable rollers.
Fork type, snap action switch.

From among the hundreds of Allen-Bradley Bulletin 801 general purpose limit switches, you're sure to find your exact requirements. There are 21 different contact arrangements available, including types with single or multiple poles, N.O. and N.C. contacts, spring return or maintained contacts, with either a slow or snap action mechanism. It will pay you to know this *quality* line of limit switches. If you do not already know this quality line, let's get acquainted. Write for the complete story.

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Edited by John R. Dunning and Bruce R. Prentice

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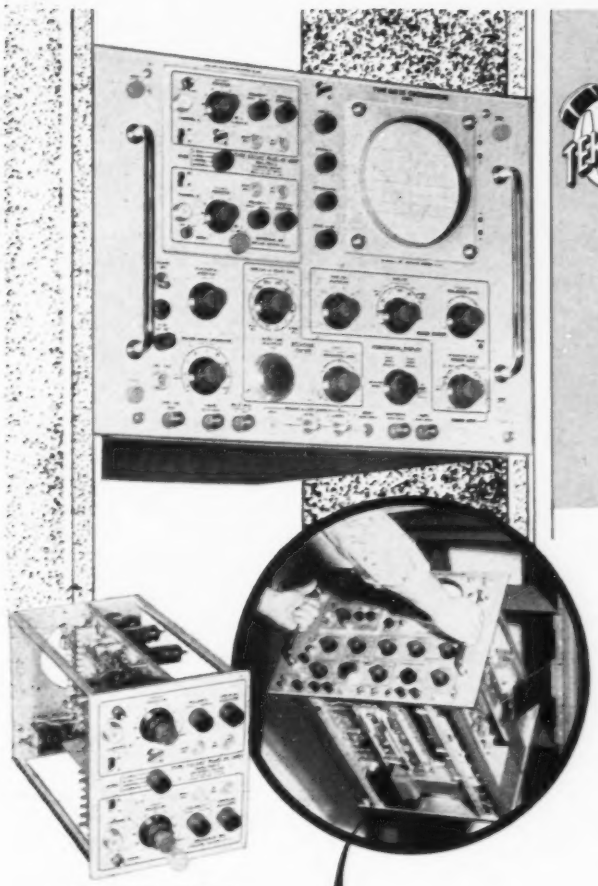
(Continued on page 70A)



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TYPE 53/54B
Wide-Band High-Gain Unit ... 125

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TYPE 53/54R
Transistor Risetime Measurement Unit (to be available soon)

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TYPE RM45
Electrically identical to Type 545

DC to 30 MC, 0.012-μsec risetime with fast-rise plug-in units.
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Calibrator—0.2 mv to 100 v.
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TYPE RM41
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The Type RM41 is also electrically the same as the Type RM45, except that it is without provision for sweep delay.
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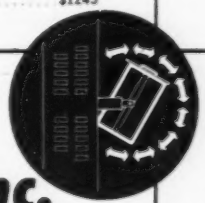

Tilt forward-backward for easy access.

TYPE RM32
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DC to 5 MC, 0.07-μsec risetime with wide-band plug-in units.
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Calibrator—0.2 mv to 100 v.
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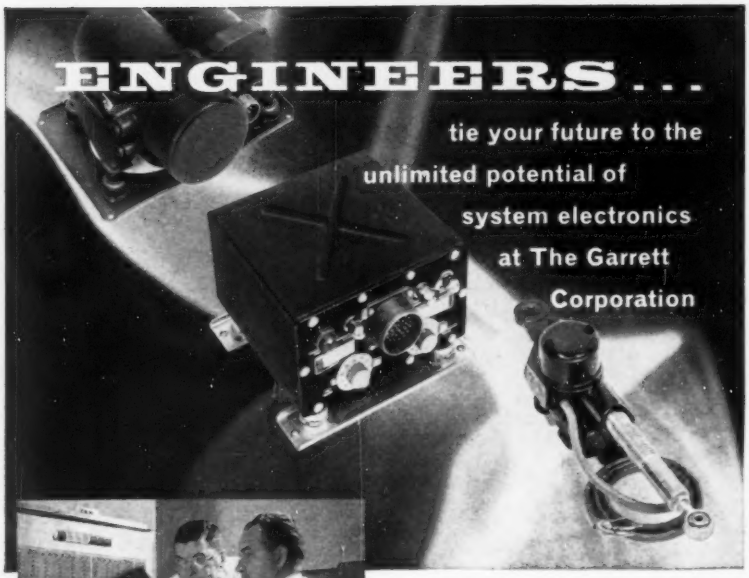

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(Continued from page 68A)

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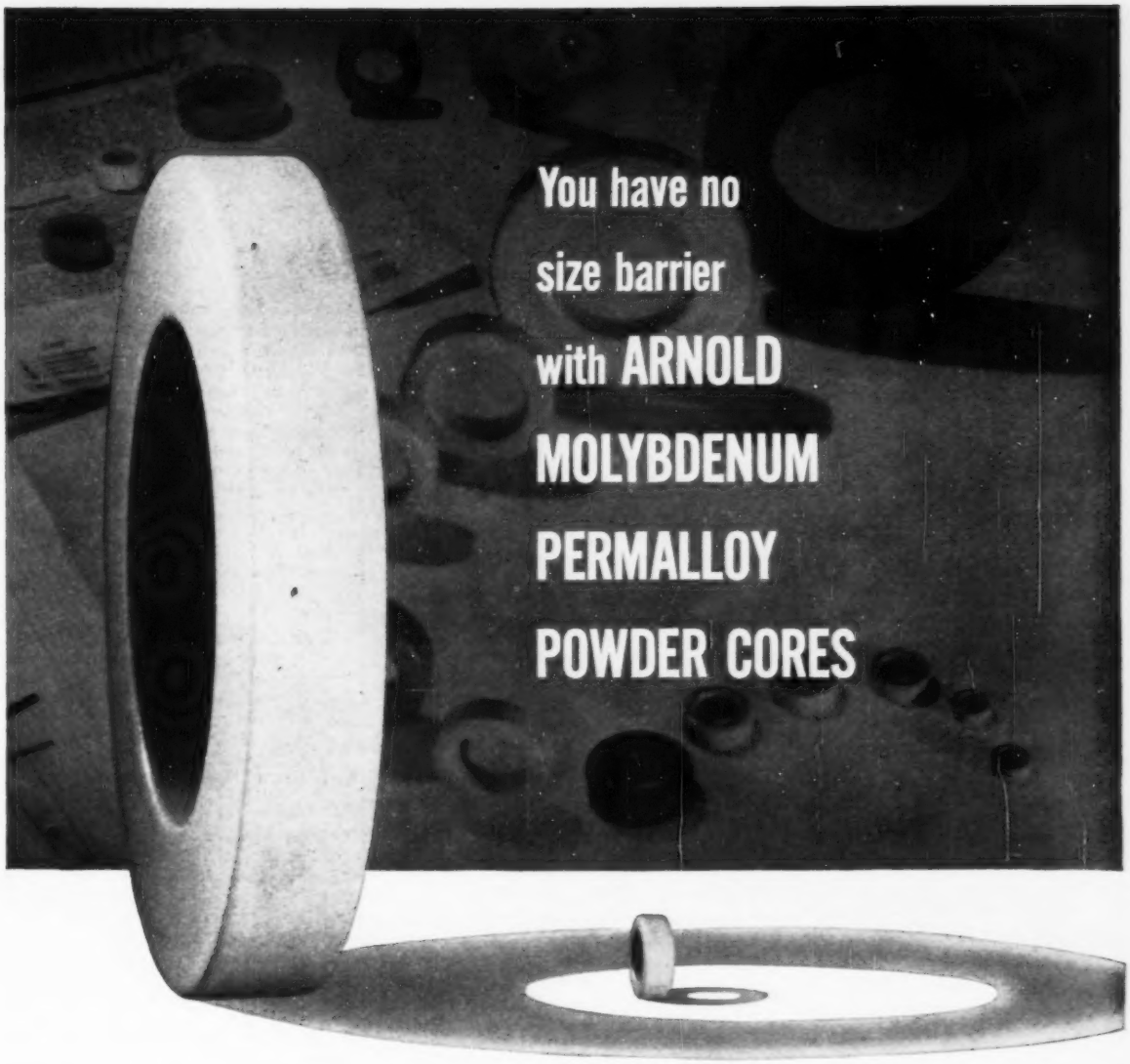

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Trade Literature

(Continued from page 54A)

Laminates Selection Guide Available. An easy guide to the selection factors and the comparative properties of typical Fiberglas reinforced laminates has been published and is now available from Electrical Division, Owens-Corning Fiberglas, 598 Madison Ave., New York 22, N. Y.

Communication Equipment Folder. "Hi-Level Communications for Industry" is the title of a 6-page folder that describes and illustrates two-way loudspeaking communication equipment for the mining industry. Equipment featured includes speakers, speaker assemblies, amplifiers, microphones, telephone handsets, cables, and junction boxes which can be applied either to single or multiple channel operation. To obtain a copy, write for Bulletin No. *1601-9*, Mine Safety Appliances Company, 201 N. Braddock Ave., Pittsburgh 8, Pa.

Lincoln Laboratory Brochure. A 12-page booklet published by the Massachusetts Institute of Technology Lincoln Laboratory describes that organization's activities and fundamental research program since its inception in 1951. Copies may be secured from M. I. T. Lincoln Laboratory, Box 24, Lexington, Mass.

Residual Stress Book. "Residual Stresses in Cold Finished Steel Bars and Their Effect on Manufactured Parts" is the title of a 32-page, pocket-size book offered free to interested readers by LaSalle Steel Company, 1420 150th St., Hammond, Ind. The material covered is a condensed version of a paper that was given at the Diamond Jubilee Semiannual meeting of the American Society of Mechanical Engineers. Copies are available free upon request.

Unit Substation Technical Library. *GET-2753*, comprising seven individual publications is now available either as a set or in any combination of individual publications by specifying the numbers. This library first published last year, is being reissued. The publications discuss several problems and solutions relating to: Distribution Substations in System Planning *(GER-1151)*, Economical Size Substations for 12-Kv Distribution *(GER-1299)*; Converting a Radial to a Primary Network Distribution System *(GER-1313)*; Master Unit Substations and Their Relay and Control Arrangements *(GET-2528)*; Integrating Substation and System Planning Requirements to Reduce Over-all System Investment *(GET-2677)*; Use of Handbooks for Substation Planning Purposes *(GEZ-1867)*; and 25 Years of Progress in Unit Substations *(GEZ-1865)*. The publications also list ratings of equipments and include charts, one-line diagrams, and pictures. General Electric Co., Schenectady 5, N. Y.

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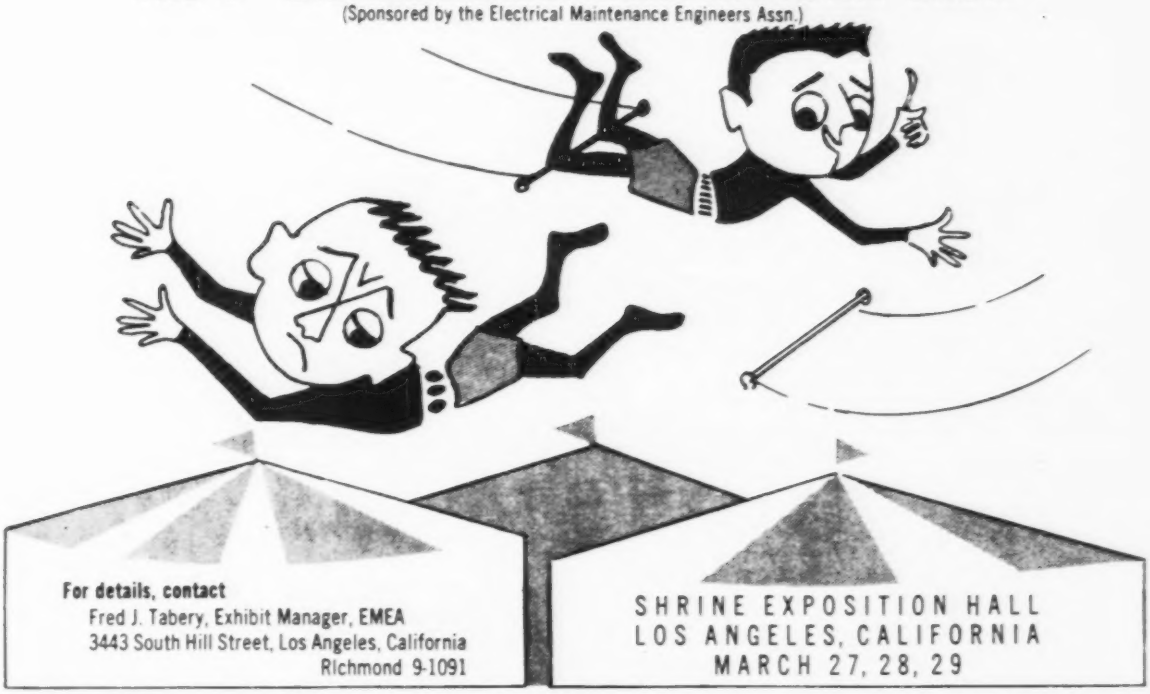

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*Tide magazine

CHECK AND COMPARE . . .

(with your own experience) these benefits leading engineers said they obtained from advertising:

- ☐ reduced maintenance costs
- ☐ improved quality
- ☐ cost reduction
- ☐ simplified manufacture
- ☐ increased capacity
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- ☐ aided research
- ☐ reduced spoilage
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- ☐ power economy
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The popular name "Green Book" now applies to this new publication rather than to Interior Wiring Design for Commercial Buildings as before. The latter publication is out of print pending revision and when the new edition is available it will be known as the "Gray Book."

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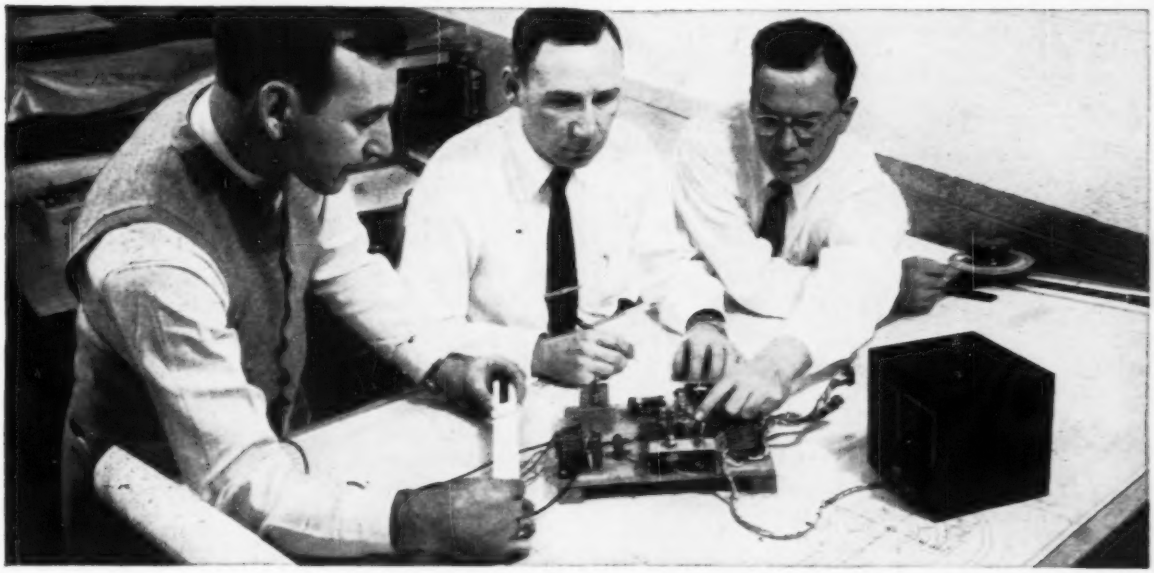

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ELECTRICAL AND ELECTRONIC NEWS No. 15

Silicone Insulated Transformers Light-Weight, Maintenance Free

Added proof that you get "more power per pound" and maximum reliability with silicone electrical insulation is provided by Moloney Electric Company's new line of 3-phase, nitrogen filled, dry-type transformers.

Take the 1500 KVA rating, for example: these units weigh only 21,000 pounds and measure less than 9½ x 5½ x 10 feet. Silicone-insulated throughout, they can be safely installed almost anywhere regardless of high ambients, contaminated or dust laden atmospheres. In addition, these transformers are virtually maintenance-free; no liquids to maintain, no toxic fumes to guard against.

Contributing to the transformers' efficient performance are the strong, lightweight silicone-glass spacer bars laminated by Formica Company into U-shapes for maximum heat dissipation. Moloney also uses Formica's G-54 silicone-glass for phase barriers and layer insulation.

To complete this all-silicone insulating system, assembled cores and coils are impregnated with Dow Corning 997 Varnish; lead wires are covered with Silastic,* the Dow Corning silicone rubber. *No. 60*

*T.M. REG. U.S. PAT. OFF.

SILICONE RUBBER ASSURES RELIABILITY OF ELECTRONIC "PACKAGES" ON B-58

In reaching for new plateaus of performance and reliability, designers are getting an assist from Silastic*, the Dow Corning silicone rubber. Typical is the extensive use of Silastic to insulate and protect the delicate electronic "packages" in the fire control system on Convair's B-58 Hustler.

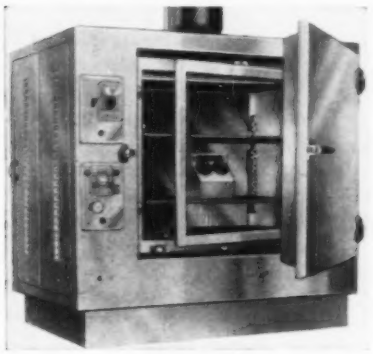
In developing the "packages," heat was a major problem encountered by the designers—the Electronics and Avionics Division of Emerson Electric Manufacturing Company. Certain rubber parts touch miniature tubes that operate at 350 F. Other rubber components, such as seals, cable grommets and clamps, are totally enclosed in packages where even the "cooling" air gets hot. Extreme cold is another problem. When the fire control system is shut off during high altitude flight, temperatures may drop to 65 below zero.

But Silastic easily withstands both extremes of temperature and physical punishment. It stays rubbery from —130 to 500 F, has excellent dielectric strength, moisture resistance and long life. That's why Emerson specified Silastic, and that's why more and more engineers are specifying Silastic for maximum serviceability and minimum maintenance cost in applications ranging from aircraft seals to industrial heaters, from traction motors to home appliances.

*T.M. REG. U.S. PAT. OFF. *No. 59*

Silicone Fluids on Insulators Stops Shorts and Grounds

Imaginative use of a silicone fluid has enabled Blue M Electric Company, Blue Island, Ill., to engineer faster response and more accurate heat control into its laboratory humidity cabinets.



Moisture condensation on the steatite grommets that support the resistance wire heating elements was always a problem in these cabinets. Moisture caused such a low resistance to ground that the elements had to be sheathed. This, of course, reduced the heat-up speed and made it more difficult to maintain accurate temperatures in the cabinets.

Blue M now controls the condensation problem by simply coating the ceramic insulators with Dow Corning 200 Fluid. The resulting water-repellent silicone surface is so successful in preventing the formation of conducting moisture films that the treated insulators withstand 1000 volts to ground even with droplets of water on their surface. As a result, Blue M has been able to change to faster, more accurate "open" elements without fear of grounds or shorts.

Blue M uses a 2% solution of Dow Corning 200 Fluid in carbon tetrachloride. The insulators are dipped into this solution and baked for one hour at 575 F. *No. 61*

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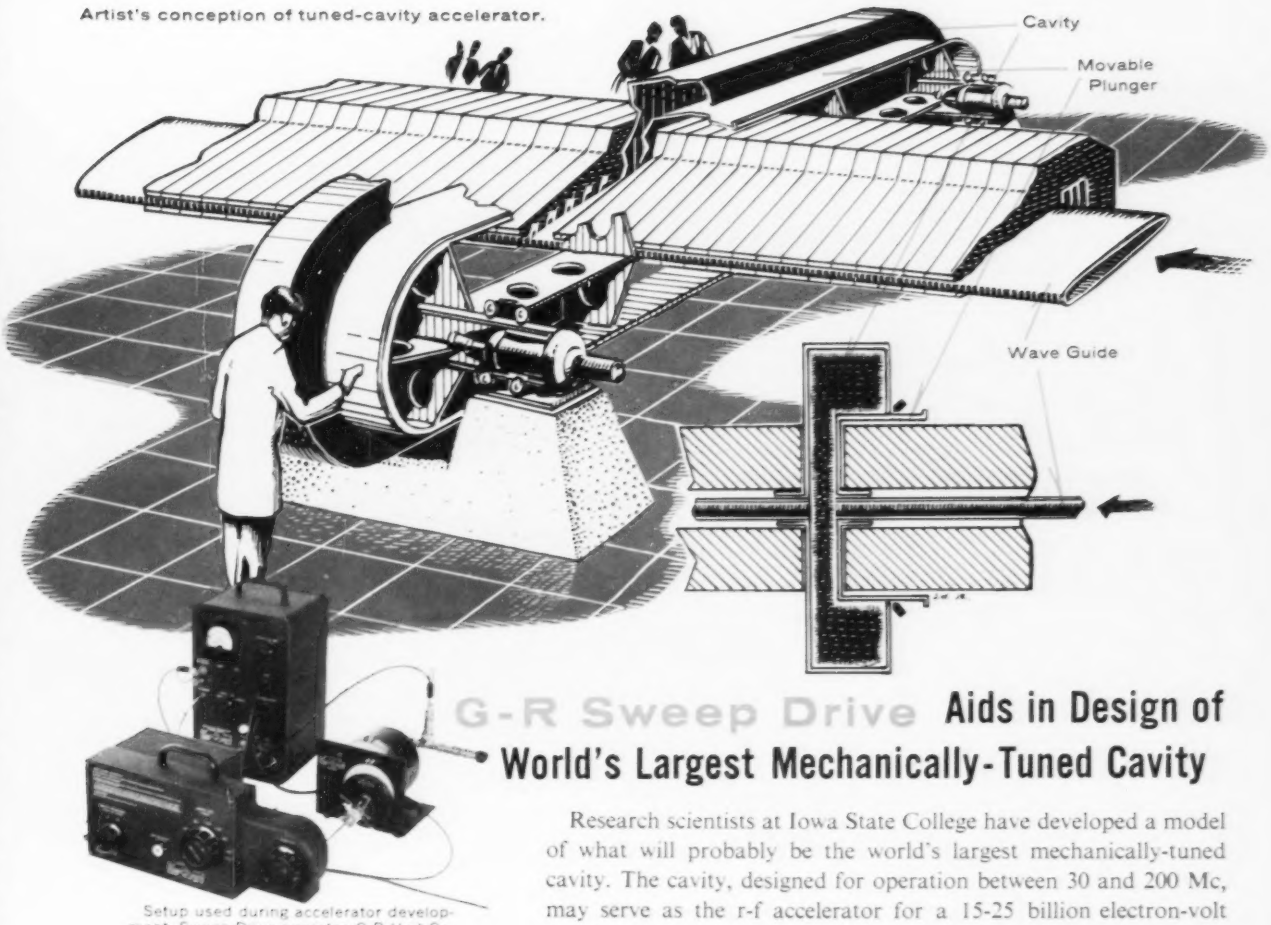
Artist's conception of tuned-cavity accelerator.



G-R Sweep Drive Aids in Design of World's Largest Mechanically-Tuned Cavity

Research scientists at Iowa State College have developed a model of what will probably be the world's largest mechanically-tuned cavity. The cavity, designed for operation between 30 and 200 Mc, may serve as the r-f accelerator for a 15-25 billion electron-volt proton synchrotron. The cavity was designed under a project conducted by the Midwest Universities Research Association, a group of midwestern universities organized for the purpose of developing this new nuclear research device.

During development, the General Radio Sweep Drive proved indispensable for determining the effects of design changes in cavity models. The Sweep Drive was coupled to a G-R Unit Oscillator which excited the cavity over a broad frequency range. The cavity output signal was rectified and applied to an oscilloscope with a long-persistence screen. With this setup, cavity response could be panoramically displayed, making cavity resonances at various modes of oscillation clearly discernable and measurable.

Whether testing accelerators or amplifiers, the Sweep Drive cuts testing time without reducing accuracy. It extends the usefulness of manually-operated equipment such as oscillators, signal generators, receivers, and analyzers. It's a time-saver, labor-saver, and cost-saver all rolled-in-one.

Setup used during accelerator development. Sweep Drive operates G-R Unit Oscillator while Type 1263-A Amplitude-Regulating Power Supply ($280) maintains constant oscillator output during sweeping. Constant output is obtained by comparing output signal with a reference voltage and applying a rapid correction voltage to oscillator plate supply.

G-R Type 1750-A Sweep Drive

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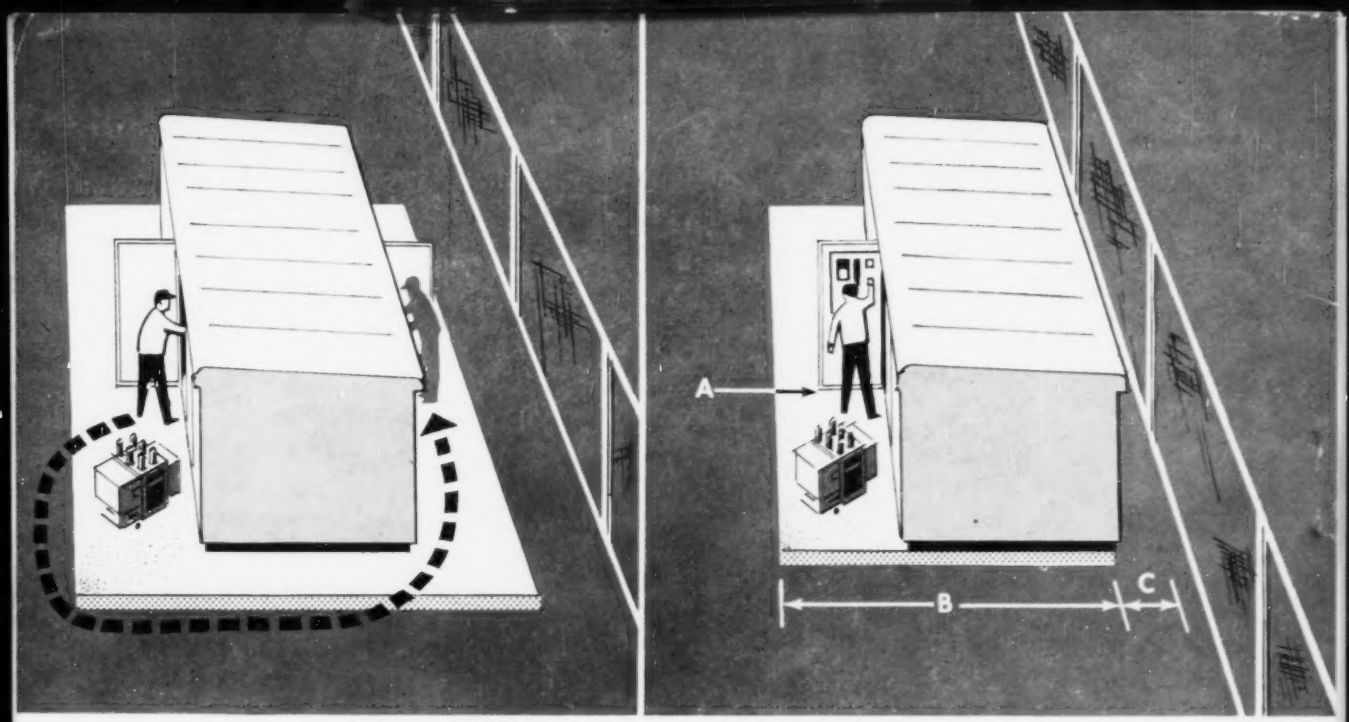
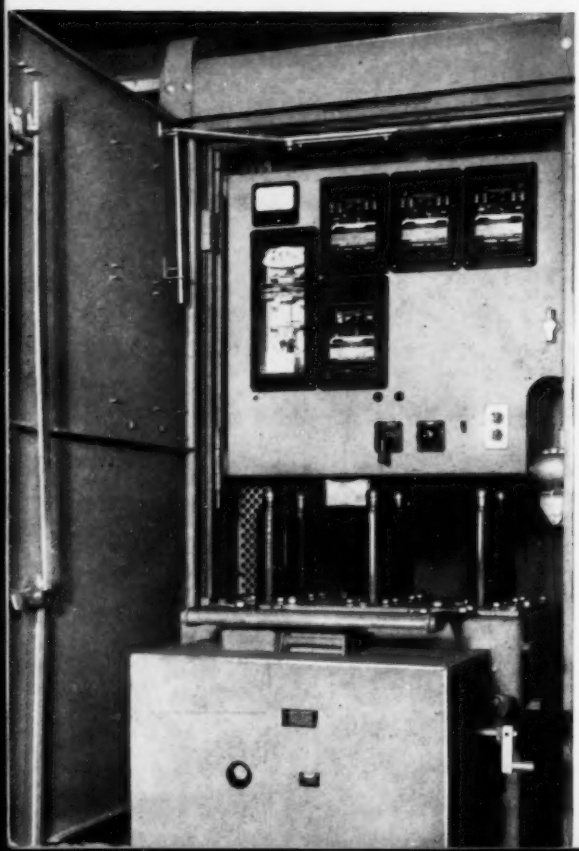


New G-E metal-clad design eliminates moving from one side of unit to other for operation or maintenance, puts breaker and control at one position (**A**). New design also allows you to (**B**) cut foundation size, and (**C**) save station space.

NEW *General Electric outdoor metal-clad design helps . . .*

Slash Installation, Maintenance Costs



To help you cut your operating budget, General Electric is building outdoor metal-clad switchgear with the control panel on the same side of the unit as the breaker.

With the new gear, you need only one operating aisle, significantly reducing foundation pad size. You save excavation costs and material. Since access to the rear of the equipment is no longer necessary, you save station space.

Maintenance and testing is easier and quicker with G.E.'s new metal-clad because the breaker, relays and control are all accessible at one position. Maintenance men will not waste expensive time moving from one side of the unit to the other. The "dutch door" control panel swings out to provide easy access to bus connections. Also, the breaker can be removed without disturbing the panel.

The new outdoor metal-clad is available with a preassembled protected aisle as optional equipment. For more information, contact your nearest General Electric Apparatus Sales Office, or write Section 511-28, General Electric Company, Schenectady 5, New York.

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